Research Product 90-11

Predicted Decay of Mobile Subscriber Equipment (MSE) Operator Skills

February 1990

Automated Instructional System Technical Area
Training Research Laboratory

U.S. Army Research Institute for the Behavioral and Social Sciences

U.S. ARMY RESEARCH INSTITUTE
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EDGAR M. JOHNSON
Technical Director

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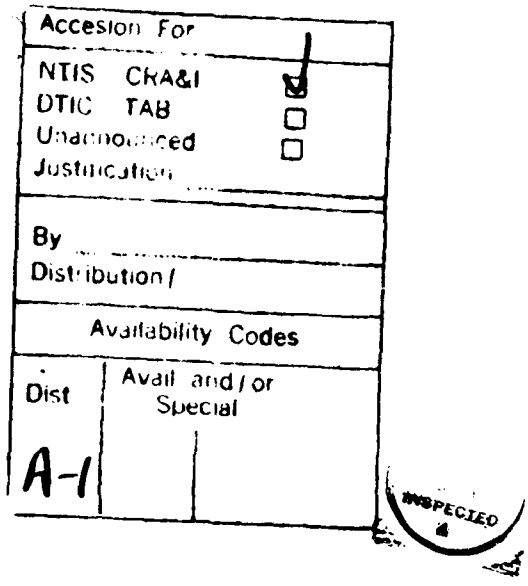
COL, IN
Commanding

Technical review by

Louis W. Buckalew
Paul J. Tremont



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Using the TRADOC skill retention model, predicted decay functions for 85 skills needed to operate the Mobile Subscriber Equipment (MSE), a new high-tech communication system, were computed. These skills relate to the operating procedures for MOS 31D, MOS 31F, and MOS 31F/ASIV4. Researchers applied the model using individual interviews with three subject matter experts for each MOS. Separate predictions were made for using and not using a technical manual. For each of the 85 operating procedures, a chart was constructed that predicts proficiency for up to 12 months after training. Most MOS 31D procedures were predicted to be well retained, while most MOS 31F/V4 procedures were predicted to be poorly retained; MOS 31F procedures were intermediate

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Mark A. Sabol, Lois G. Chapell, and Carolyn Meiers
U.S. Army Research Institute

Automated Instructional System Technical Area
Robert J. Seidel, Chief

Training Research Laboratory
Jack H. Hiller, Director

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

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Manpower, Personnel, and Training

FOREWORD

A major focus of Army training is the sustainment of skills. As more advanced technologies are incorporated into Army equipment, the skills required to operate it become more complex and more difficult to retain. Within the Training Research Laboratory of the U.S. Army Research Institute for the Behavioral and Social Sciences, the Technologies for Skill Acquisition and Retention Technical Area has been conducting research to construct a model that predicts the decay of complex skills.

This research describes the first phase in the construction of such a model. Predicted decay functions for 85 skills needed to operate the Mobile Subscriber Equipment (MSE), a new high-tech communication system, were computed using a current model of skill retention for straight-forward procedural skills. Representatives from the Signal School, Fort Gordon, Georgia, were briefed on the results of this first phase on 28 July, 1989. Further work will compare MSE operator performance to the predictions of this current model. Based on this research, adjustments will be made in the model to allow predictions for more complex, cognitive skills.

EDGAR M. JOHNSON
Technical Director

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at the 442D Signal Battalion--

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CPT Lane, Company D

at the Operational Test and Evaluation Agency (OTEA)--

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CPT Mulcahy

at the Signal School, Fort Gordon--

Ms. Mousseau, MSE Cell, Area Communication Department

at the U.S. Army Research Institute for the Behavioral and Social Sciences--

Dr. Sanders, Fort Gordon Field Unit
Dr. Buckalew, Fort Hood Field Unit

PREDICTED DECAY OF MOBILE SUBSCRIBER EQUIPMENT (MSE) OPERATOR SKILLS

CONTENTS

PREDICTED DECAY OF MOBILE SUBSCRIBER EQUIPMENT (MSE) OPERATOR SKILLS

INTRODUCTION

This Research Product is the outcome of the first stage of an extended program on military skill retention. The final goal of this program is the development of a model that can predict the degradation of complex skills over time. In this first phase, operation of Mobile Subscriber Equipment (MSE) was used as an example of a task involving complex procedural skills; predicted decay curves were obtained for 85 skills involved in MSE operation. It is hoped that this initial product will be helpful to trainers by sensitizing them to skill areas prone to rapid decay and useful to commanders as they schedule refresher training for units being fielded with the new MSE system.

MSE is a "high-tech" radio telephone system designed to provide secure communications over a five-division corps area. MSE is complex technology and its optimal use requires the smooth performance of complex procedural skills by its operators. In addition, MSE was acquired as a non-development item (NDI), in order to allow its rapid fielding, and will eventually be used by both the Active Army and the Reserve Component. These factors have given rise to a number of personnel selection and training concerns. Chief among these concerns is the extent to which critical operator skills will be retained over extended periods without practice.

The MSE acquisition is, therefore, an opportunity for conducting timely and useful skill retention research. The results of this research will serve two purposes: 1) to predict retention of MSE operator skills, in particular, and 2) to expand an existing retention model to cover more complex skills, in general.

This existing model of skill retention is one which ARI developed (Rose, Hagman, Radtke, & Shettel, 1985) and TRADOC published as the User's Manual for Predicting Military Task Retention (TRADOC Form 321-R). The use of this manual has been demonstrated to predict accurately

the decay of simple procedural skills, such as weapon dismantling and reassembly (Rose, Czarnolewski, Gragg, Austin, Ford, Doyle, & Hagman, 1985). However, it is unclear to what extent this model applies to more complex procedures or to skills involving such cognitive aspects as decision making and planning. The application of the current model to MSE skills, which are considered to be complex and mildly cognitive in nature, is the first phase in evaluating the model's applicability to such skills. The next step will be to determine the actual retention of these skills over various periods and to compare actual performance with that predicted.

The results of the first step in this application are presented in this paper. The existing model has been applied as instructed to MSE operator tasks, producing prediction of retention for each of 85 skills. Of these, 33 are skills to be performed by MSE Network Transmission Operators (MOS 31D) and 52 are to be performed by MSE Network Switch Operators (MOS 31F). Moreover, there is, within MOS 31F, the Additional Skill Identifier (ASI) V4; 20 skills were from ASI V4.

METHOD

Subjects.

Six subject matter experts (SMEs) were identified within Delta Company, 442nd SIG BN, Fort Gordon, Georgia, by recommendation of their company commander. Three of these SMEs were expert on the MOS 31D procedures and three were expert on MOS 31F procedures. The SMEs qualified as experts on MOS 31F were qualified on ASI V4.

Selection of Tasks/Procedures.[1]

1 In some usages, the term "task" refers to a broad accomplishment to be achieved (for example, operating a radio-telephone), while the term "procedure" is used to refer to a specific sequence of steps taken to perform a task or part of a task. Likewise, the ability to perform a procedure (or accomplish a task) successfully is termed a "skill." However, the User's Manual employed here uses the term "task" in the most general sense, as any job to be performed. In this paper, therefore, the three terms are used interchangeably; no implication is intended by a particular choice in any instance.

Candidate procedures were obtained from two sources: 1) exhaustive inventories generated during the development of the MSE Soldier's Manuals by the Area Communication Department, MSE Cell, Signal Center, Fort Gordon, and 2) lists of important skills generated during field evaluation of MSE by the U. S. Army Operational Test and Evaluation Agency (OTEA). From these, a total of 85 procedures were chosen to be rated; 33 of these procedures were from MOS 31D, 32 from MOS 31F, and 20 from MOS 31F ASI V4. These 85 procedures include all the "operate" tasks from the Signal Center inventories (but only a few of the "install" and none of the "maintain" tasks). Likewise, all of OTEA's important operator skills were represented in the final list of rated procedures.

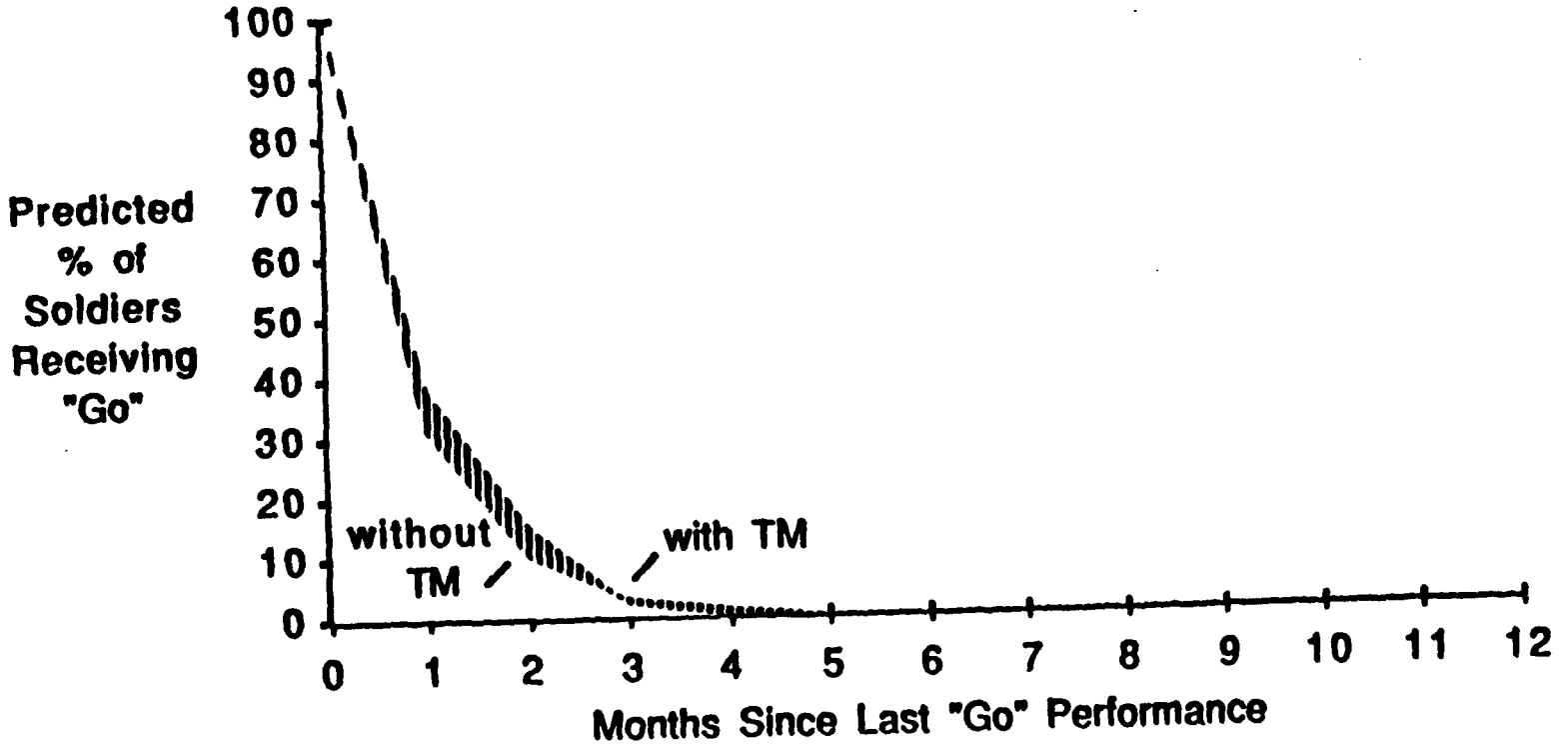
Interview Procedure.

The same person conducted all interviews. Each SME was interviewed separately, in accordance with the instructions in the User's Manual for Predicting Military Task Retention. Each interview was conducted in one session which lasted approximately two hours for the MOS 31D tasks and approximately three hours for the MOS 31F tasks. A ten-minute break was given every hour to maintain attention and enthusiasm.

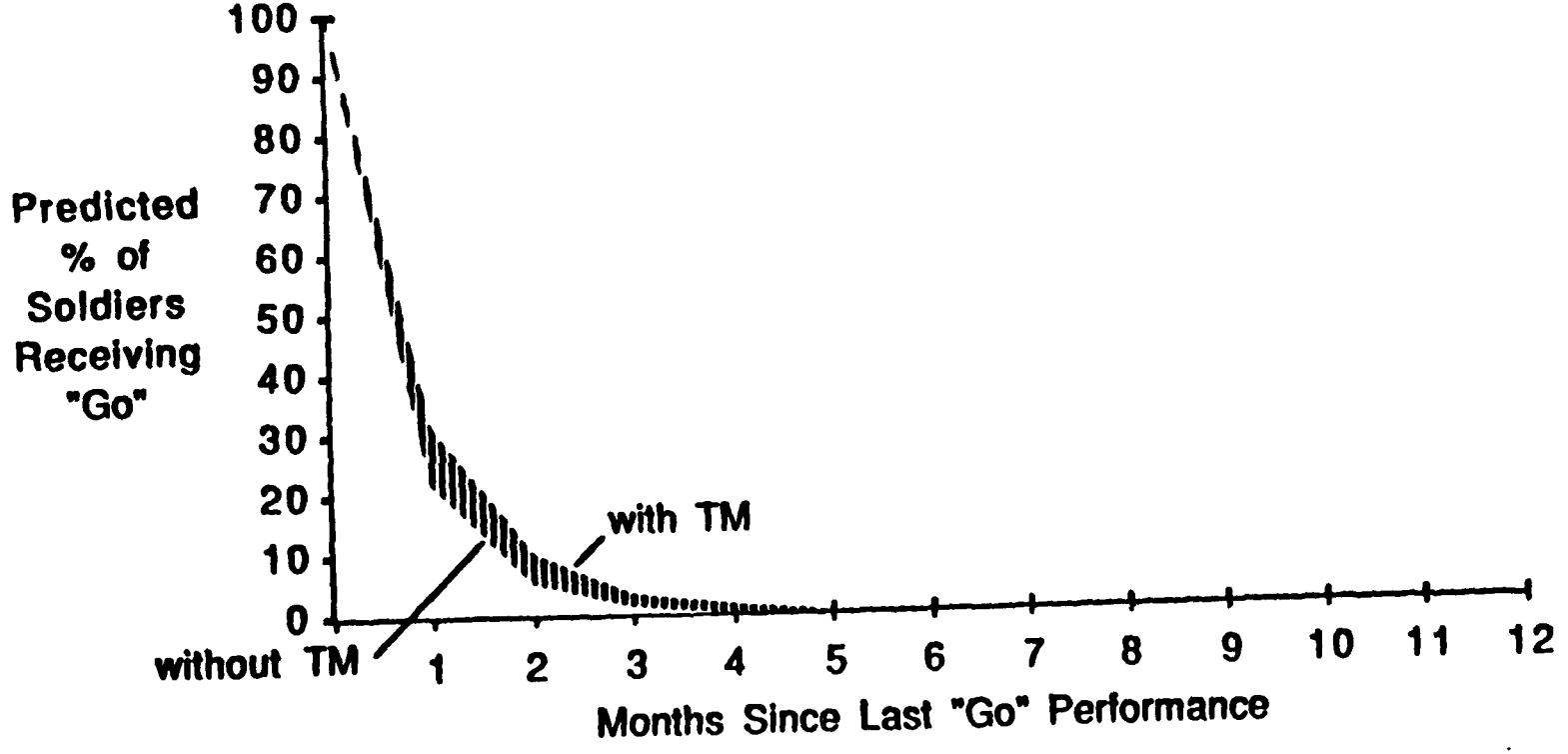
The interviewer explained the purpose of the interview to the SME as part of a test of a model of skill retention; it was emphasized that the interview would not be used as an evaluation of the SME's knowledge. Confidentiality of responses was guaranteed.

The SMEs were then asked to study the list of tasks to be rated in their MOS and to indicate whether they felt comfortable responding as experts on those tasks. All SMEs indicated that they were confident of their expertise. A brief explanation of the instruction was then given, beginning with a quick reading of the ten questions to be asked about each task. These ten questions are listed below (Table 1) as given in the User's Manual, along with abbreviated response alternatives. (The numbers and instructions in parentheses show the relative weights given particular answers during scoring.)

Perform Data Base Modification to Accommodate an Interface to an Adjacent Network via Troposcatter (AN/TTC-170)



Perform Data Base Modification to Accommodate an Interface with an Adjacent Network Using TACSAT (AN/TRC-93)



Modify a DTG down from an AN/TTC-47 DTG to an AN/TRC-46 DTG

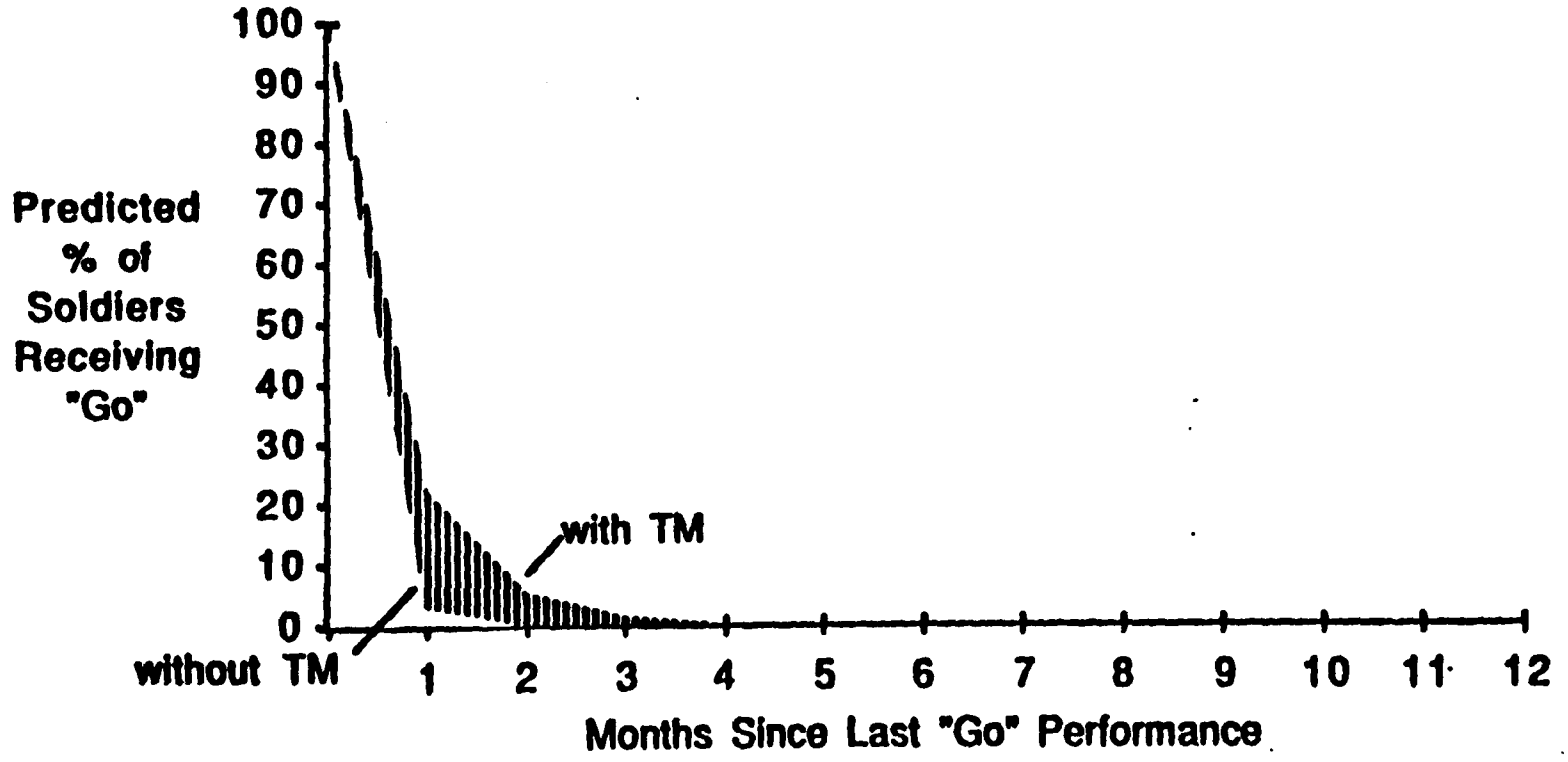


Table 1
Interview Questions
(from User's Manual for Predicting Military Task Retention):

1. Are job or memory aids used by the soldier in performing (and in the performance evaluation of) this task?
   - Yes (1)
   - No (0)

2. How would you rate the quality of the job or memory aid?
   - Excellent (56 and skip to question #6)
   - Very Good (25)
   - Marginally Good (2)
   - Poor (1)

3. Into how many steps has the task been divided?
   - One (25 and skip to question #6)
   - Two to five (14)
   - Six to ten (12)
   - More than ten (0)

4. Are the steps in the tasks required to be performed in a definite sequence?
   - None are (10)
   - All are (5)
   - Some are and some are not (0)

5. Does the task provide built-in feedback so that you can tell if you are doing each step correctly?
   - has feedback for all steps (22)
   - has feedback for most steps (19)
   - has feedback for <50% of steps (11)
   - has no built-in feedback (0)

Table 1 (continued)
Interview Questions

6. Does the task or part of the task have a time limit for its completion?
   - No, there is no time limit (40)
   - Yes, but it is easy to meet (35)
   - Yes, and it is hard to meet (0)

7. How difficult are the mental processing requirements of this task?
   - There are almost none (37)
   - There are simple requirements (28)
   - They are complex (3)
   - They are very complex (0)

8. How many facts, terms, names, rules or ideas must a soldier memorize in order to do the tasks?
   - None (20)
   - 1 to 3 (18)
   - 4 to 8 (13)
   - More than 8 (0)

9. How hard are the facts, terms, etc., that must be remembered?
   - There are none to remember (34)
   - Not hard at all to remember (31)
   - Somewhat hard to remember (12)
   - Very hard to remember (0)

10. What are the motor control demands of the task?
   - No motor control is needed (2)
   - A small but noticeable degree (0)
   - A considerable degree (16)
   - A very large degree needed (3)

During the explanatory session, particular emphasis was placed upon the definitions of terms in the questions and response alternatives. For example, what constitutes a memory aid and what dimensions should be considered when deciding that a memory aid is excellent rather than merely very good? What is meant by "complex mental processing requirements" or "a considerable degree of motor control"? These explanation were taken directly from the User's Manual, which anticipates most questions and provides clarifying examples.

Once the interview process was understood, the interviewer named a procedure, allowed a moment for the SME to call the procedure to mind, asked the first of the ten questions, and read the potential responses. If the SME had difficulty selecting a response, the interviewer again referred to the User's Manual to read the explanations and examples; clarification continued until the SME could confidently choose one of the response alternatives. The remaining nine questions were then asked about the same procedure in the same fashion. This entire process was repeated for all procedures in the SME's area of expertise.

Once the interview was complete, the SME was debriefed. The role of the interview was explained, including how the SME's responses would be used to develop a model to predict retention of complex skills, such as those used in MSE operation. After any questions were answered, the SME was thanked and dismissed.

RESULTS

For each of the ten questions in the manual's interview protocol, the three responses obtained from the three different SMEs were converted to one response by determining the median. (This helps to mitigate the effects of the lack of agreement found among SMEs; the maximum inter-rater reliability found was $r=.42$.) The ten median scores were then summed to obtain a total score for each procedure; this sum constitutes the first data point for a given procedure. A second data point was obtained for each procedure by calculating the sum over the last eight interview questions, that is, excluding those two pertaining to the existence and quality of a job

or memory aid. For all of the MSE procedures listed, this job or memory aid turned out to be the soldier's Technical Manual (TM), which is easily accessible inside the shelter which houses the MSE equipment. There were, therefore, two scores obtained for each procedure -- one "with TM" and one "without TM."

Using the Performance Prediction Tables in the User's Manual, these total scores were then converted to the percentages of soldiers predicted to receive a "Go" after various intervals without practice. These results were then plotted. Each chart shows predicted retention over a 12-month period in two curves, one for the situation in which the soldier uses the TM and one in which the procedure is performed without it.

Appendices A, B, and C show these charts for MOS 31D, MOS 31F, and MOS 31F ASI V4, respectively. Within each appendix, the charts are organized to present first those procedures for which good retention was predicted (with the TM used, greater than 75% of soldiers were predicted to receive a "Go" two months after training), then those procedures for which moderate retention was predicted (with the TM, 50-75% of soldiers expected to receive a "Go" after two months without practice), and finally those for which relatively poor retention was predicted (less than 50% of soldiers predicted to receive a "Go" at two months). The pie charts below (Figure 1) show the proportions of each set which fall into these categories. Figure 1 indicates that a large majority of the MOS 31D procedures were predicted to be well retained, while a majority of the MOS 31F ASI V4 procedures were predicted to be poorly retained; MOS 31F was predicted to have a more even distribution of procedures retained poorly, moderately, and well.

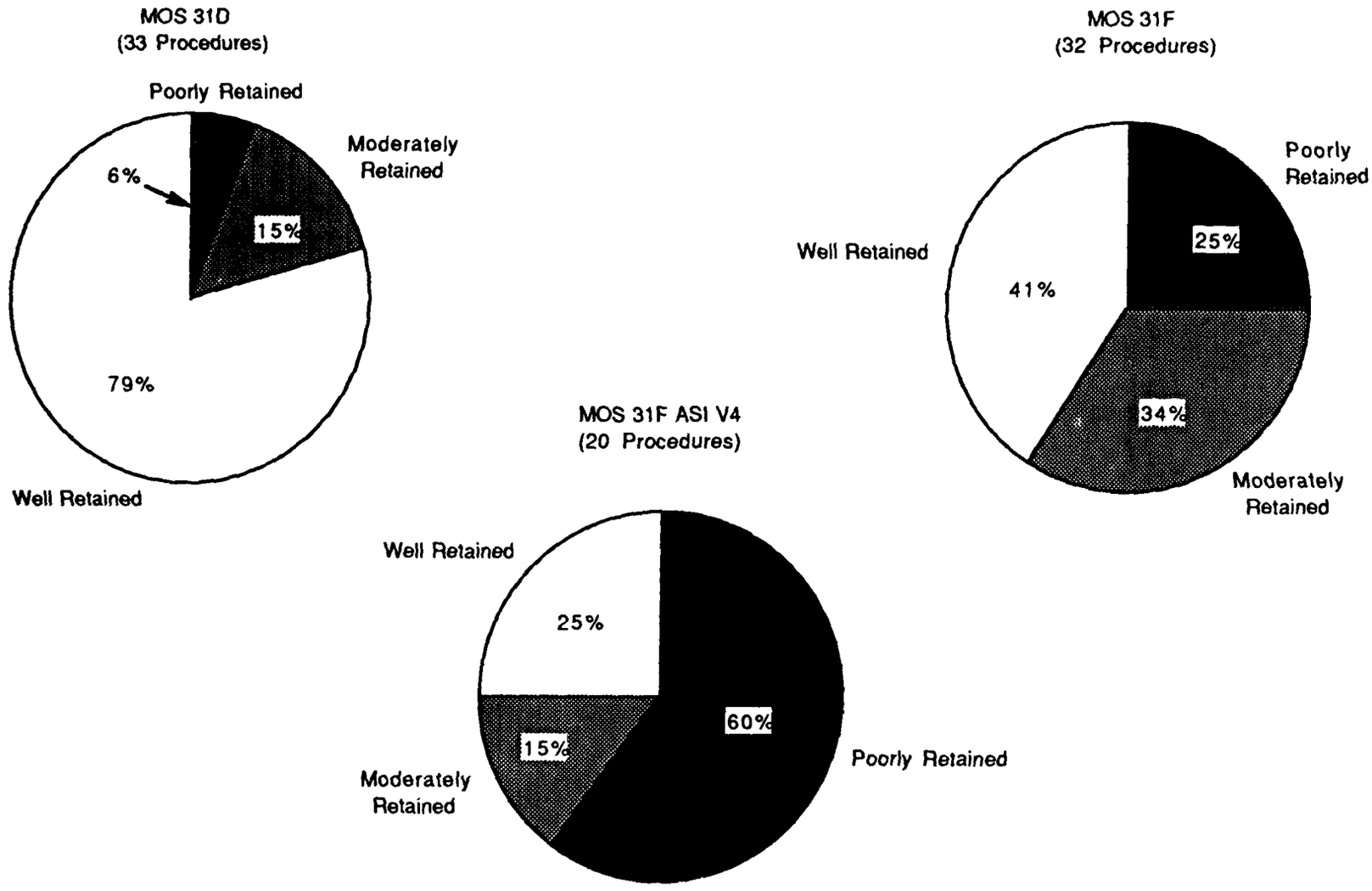


Figure 1. Percentages of the procedures rated which were predicted to be easy to retain, moderately retainable, and difficult to retain, separately for each MOS and an ASI.

UTILIZATION

The charts in the appendices provide a basis upon which the Signal Center and unit trainers could plan instruction to emphasize those procedures predicted to be poorly retained. The charts can, for example, be used to schedule refresher training to ensure that predicted proficiency never falls below an acceptable level. However, the low inter-rater reliabilities obtained indicate that these charts should be interpreted with caution until they are confirmed by further research; replication of this first stage of the project through interviews with additional SMEs is currently under way.

The next phase of the skill retention project will assess the validity of these predictions. In that phase, soldiers' proficiency on a sample of the procedures covered here will be measured immediately after training and again after several months with little or no practice. The change in proficiency between the two measurements will provide an empirical value for the retention of each procedure. Such values will then be used to assess the validity of the current model as a predictor of the retainability of MSE operator skills.

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Rose, A. M., Czarnolewski, M. Y., Gragg, F. E., Austin, S. H., Ford, P., Doyle, J., & Hagman, J. D. (1985). Acquisition and Retention of Soldiering Skills. ARI Technical Report 671.

Rose, A. M., Hagman, J. D., Radtke, P. H., & Shettel, H. H. (1985). User's Manual for Predicting Military Task Retention. ARI Research Product 85-13.

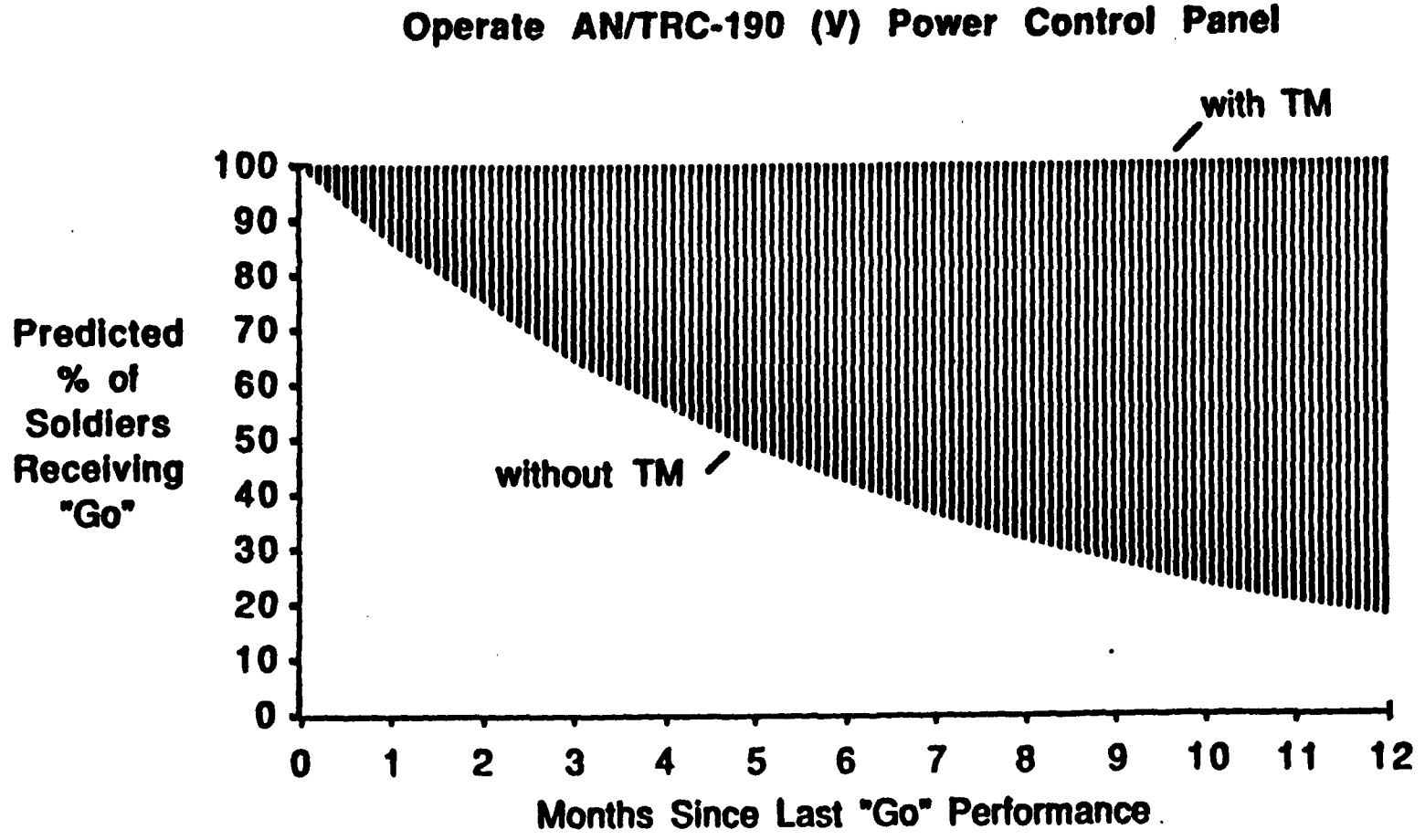
APPENDIX A

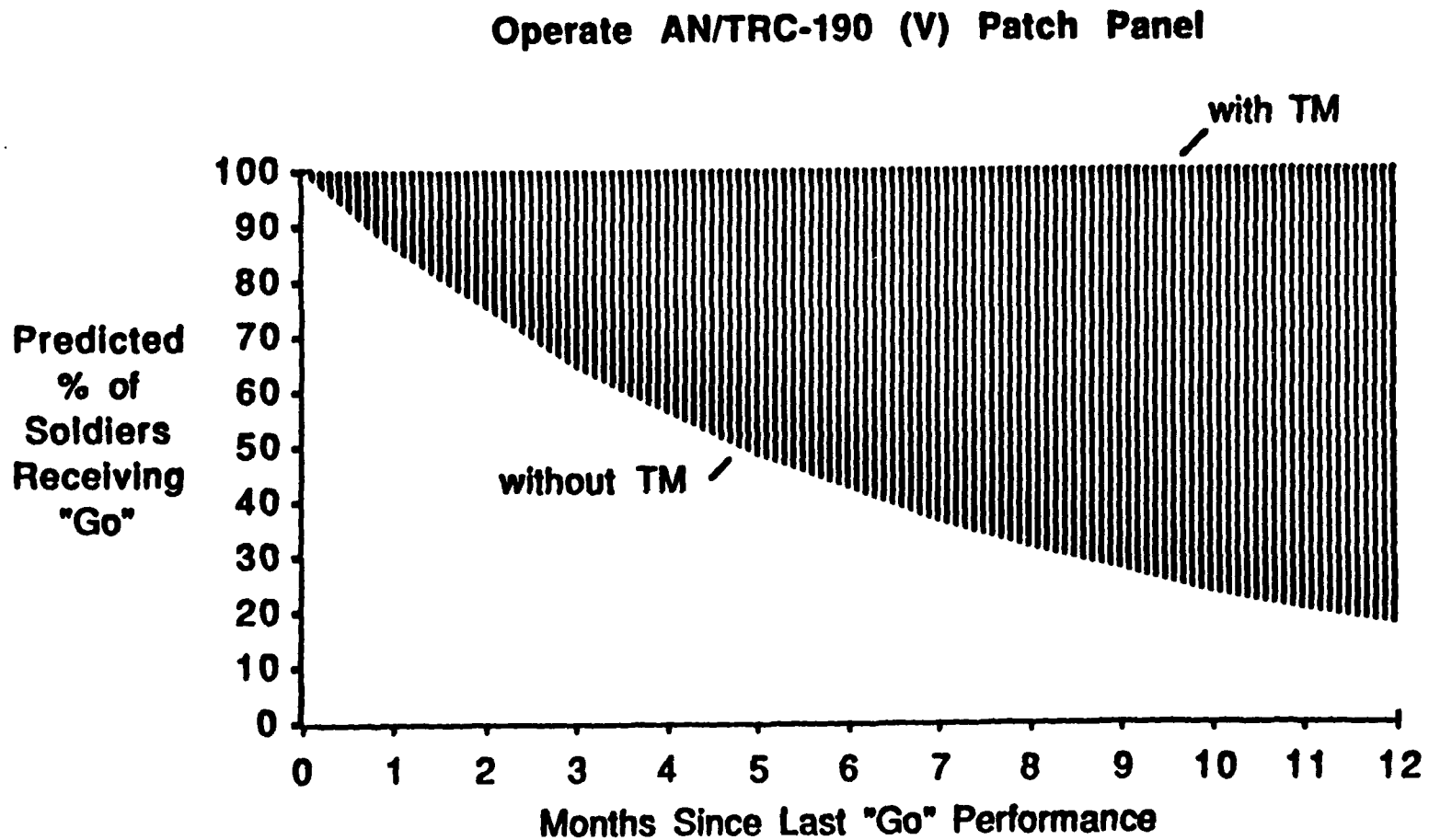
MOS 31D Procedures

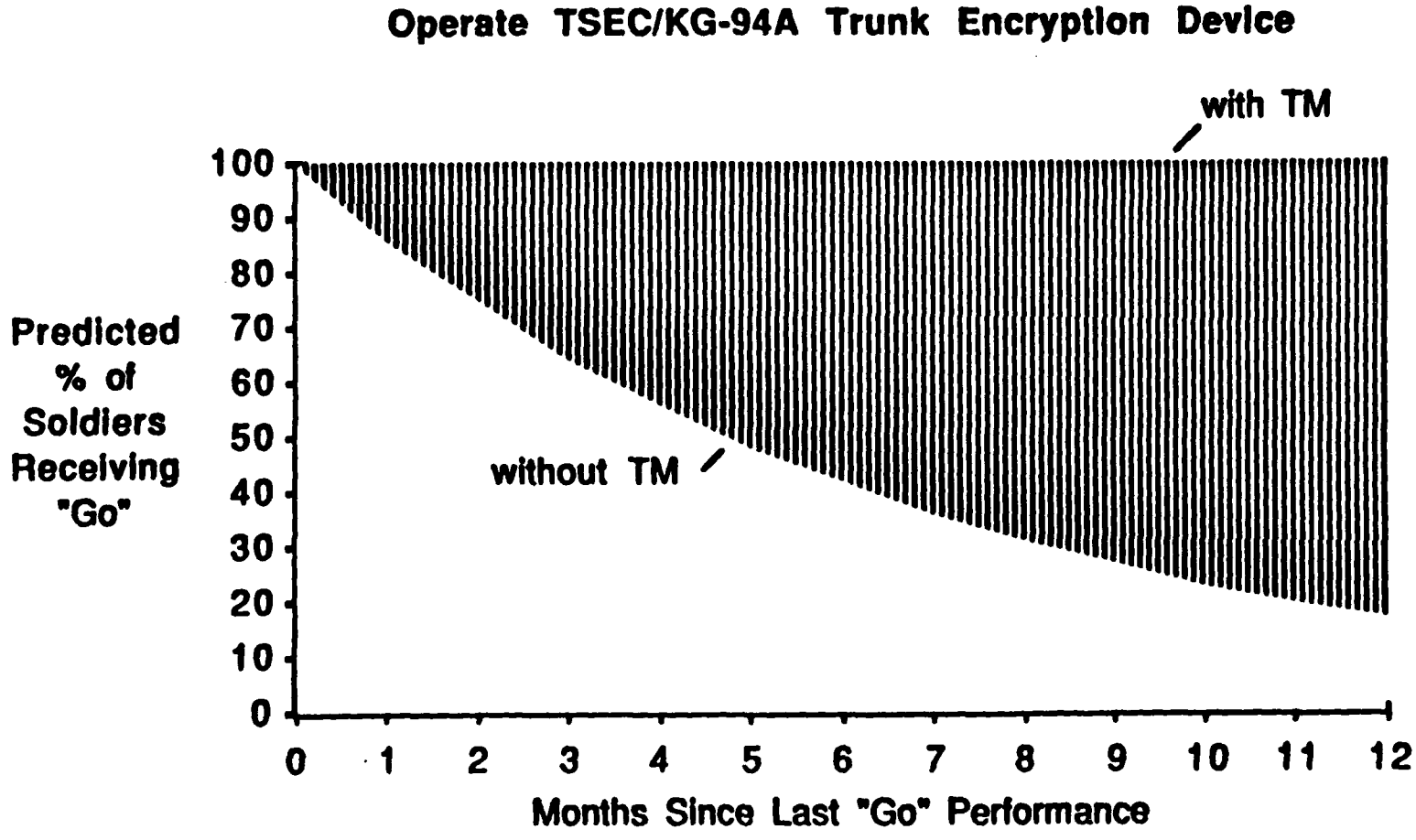
Well-retained:

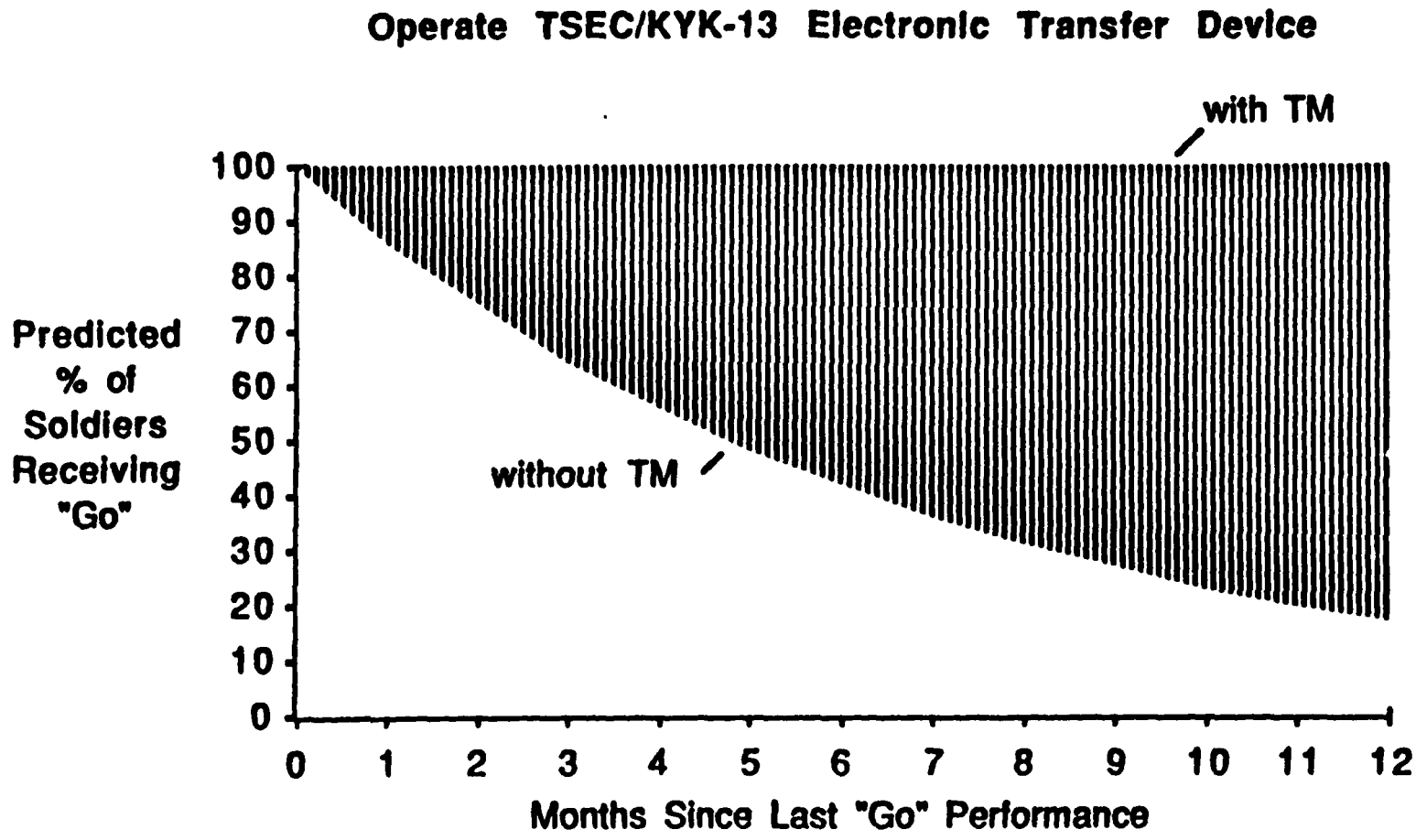
APPENDIX A

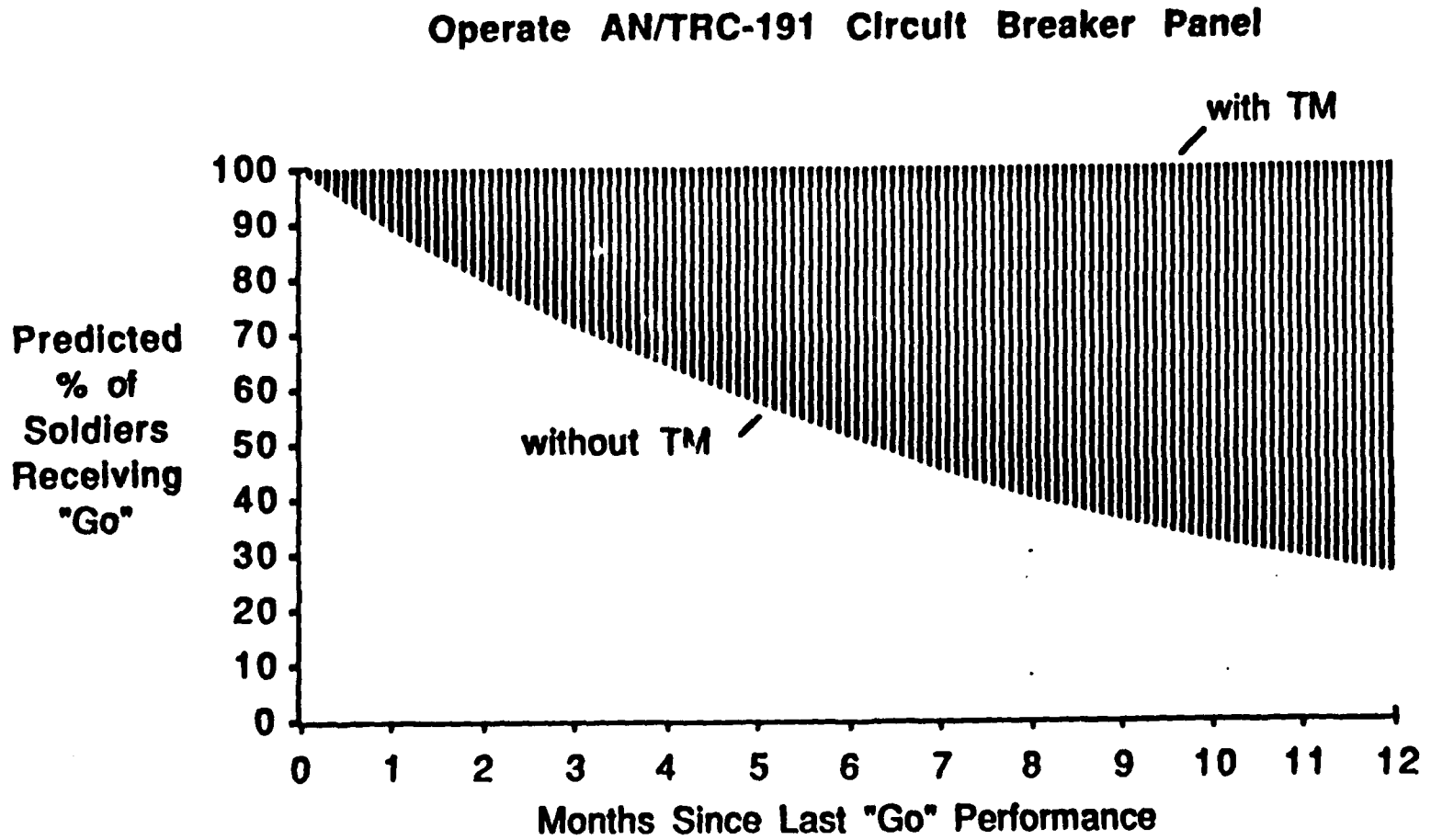
MOS 31D Procedures (continued)


Operate AN/TRC-190 (V) Power Control Panel
with TM
without TM
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance

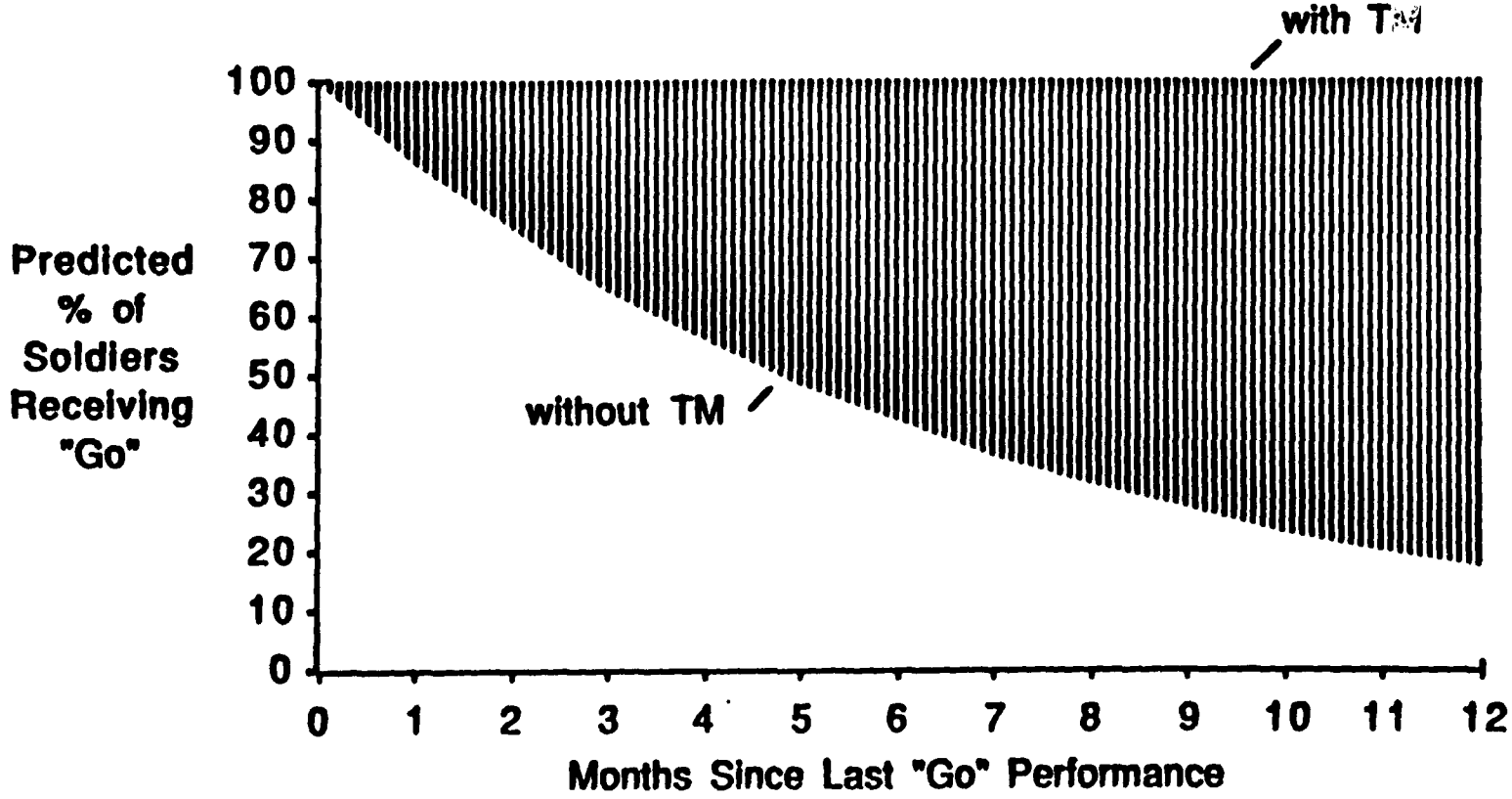

Operate AN/TRC-190 (V) Patch Panel
with TM
without TM
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance


Operate TSEC/KG-94A Trunk Encryption Device
with TM
without TM
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance

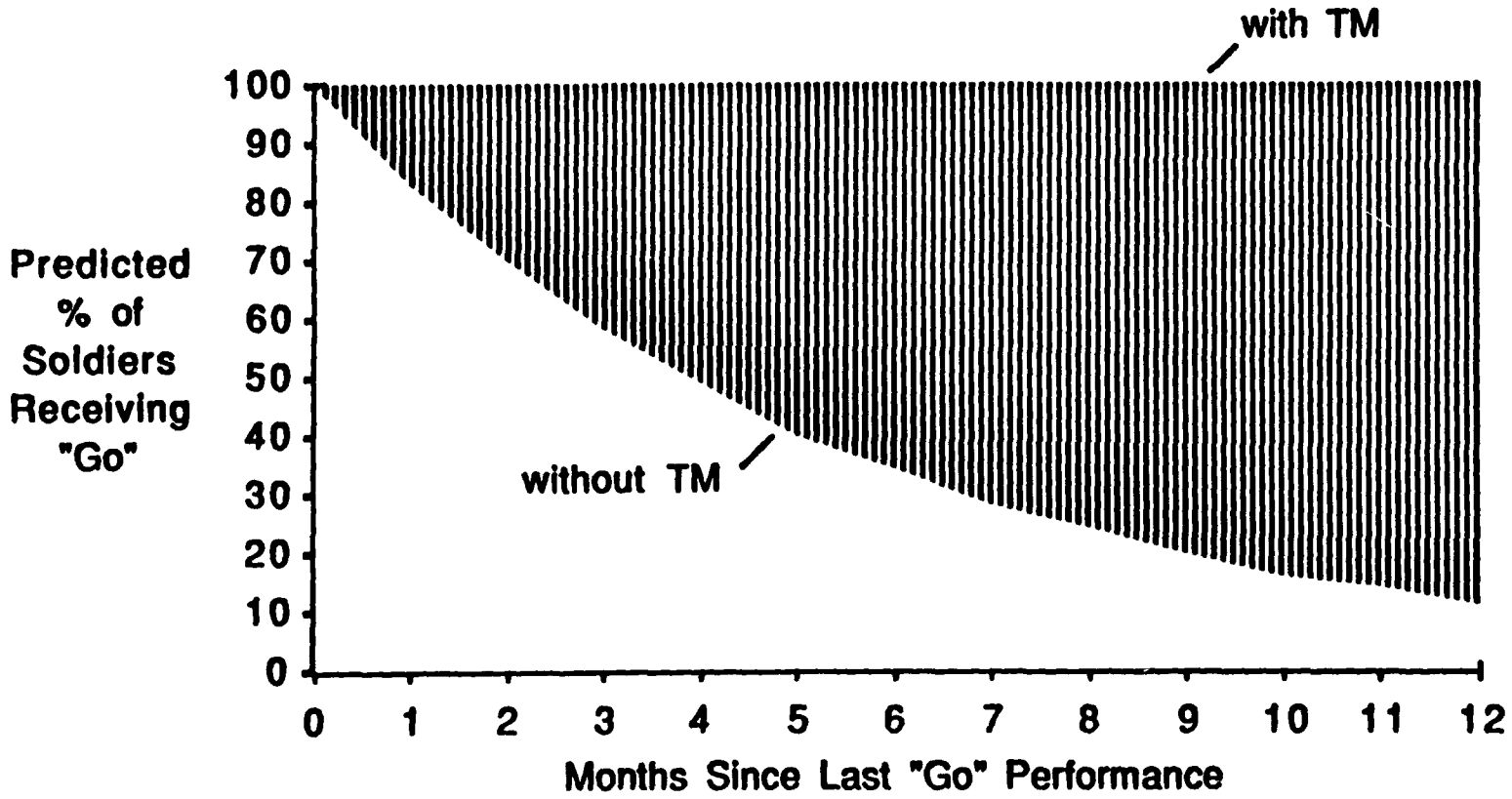

Operate TSEC/KYK-13 Electronic Transfer Device
with TM
without TM
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance


Operate AN/TRC-191 Circuit Breaker Panel
with TM
without TM
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance

Operate TSEC/KY-68 Digital Secure Voice Terminal (DSVT)



Operate RT-1539 (P)(A)(C)/G Receiver-Transmitter



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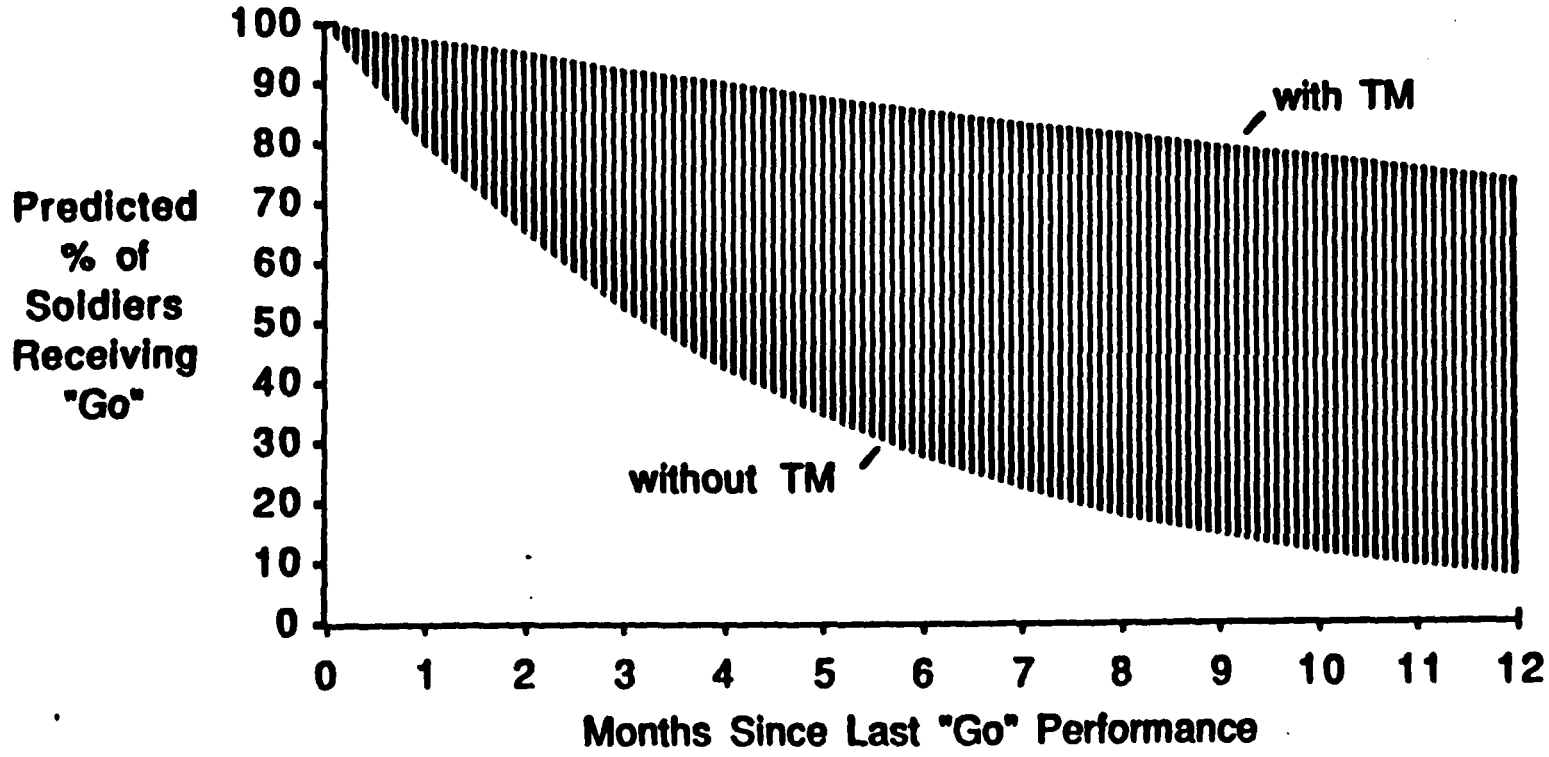
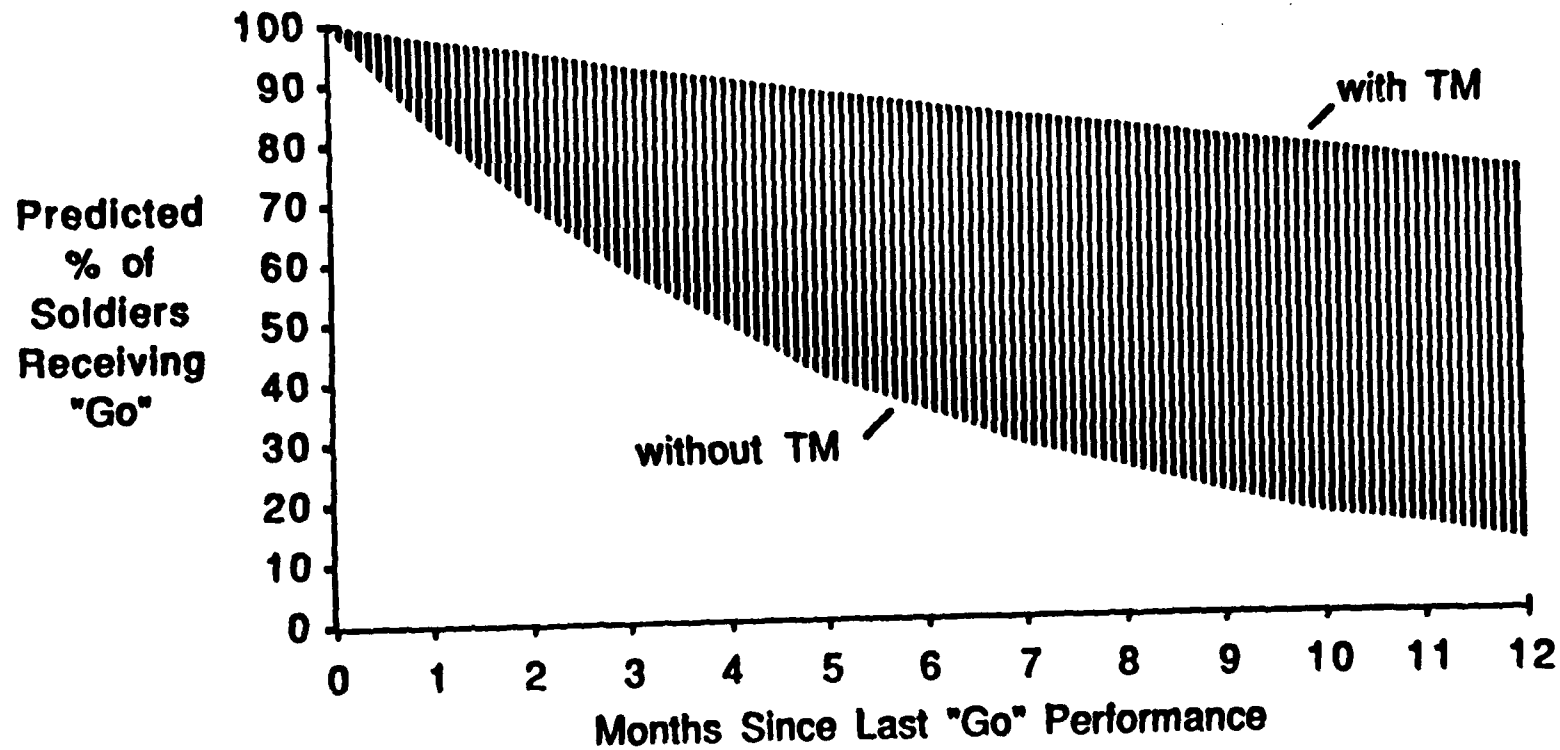
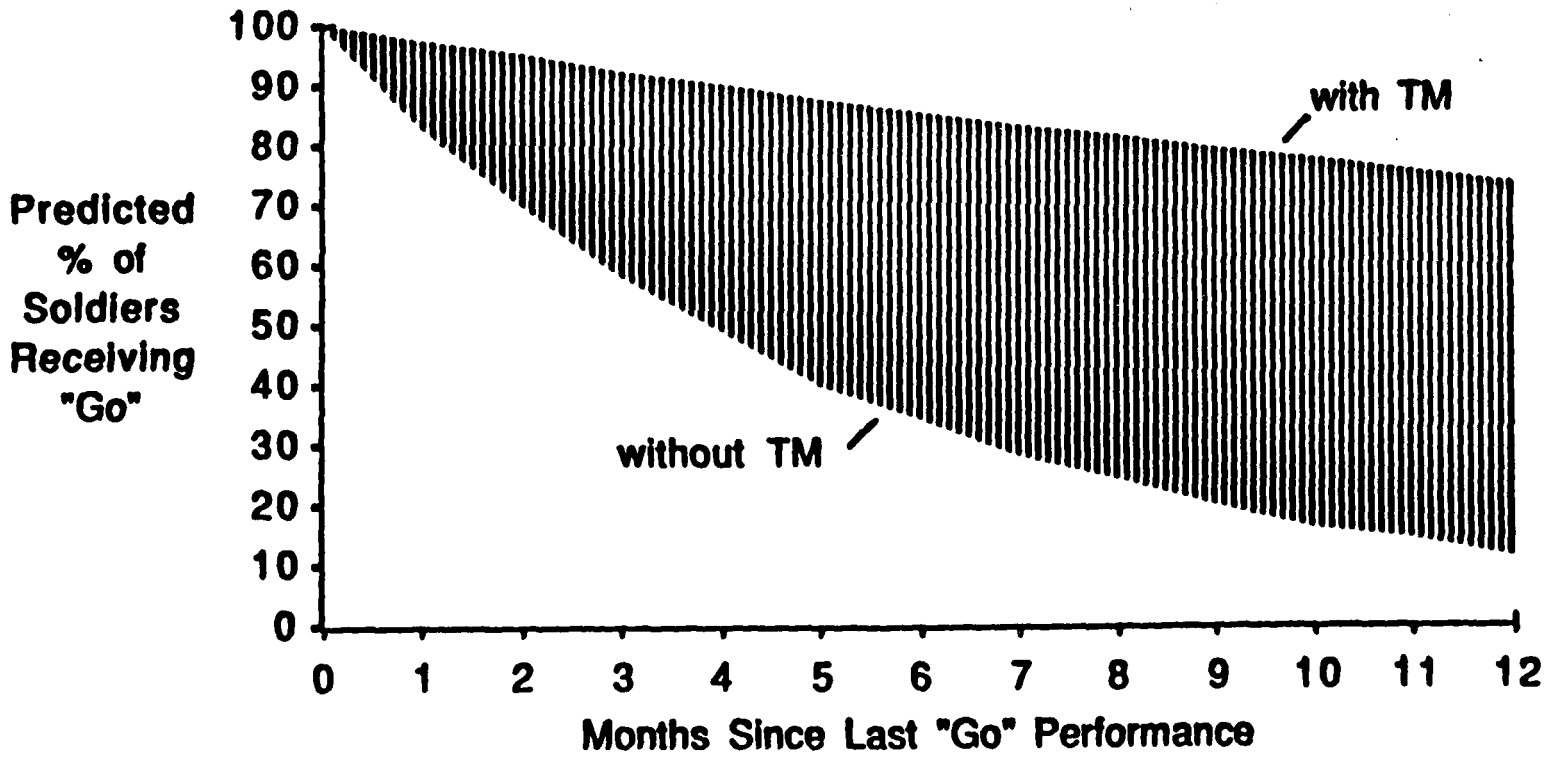
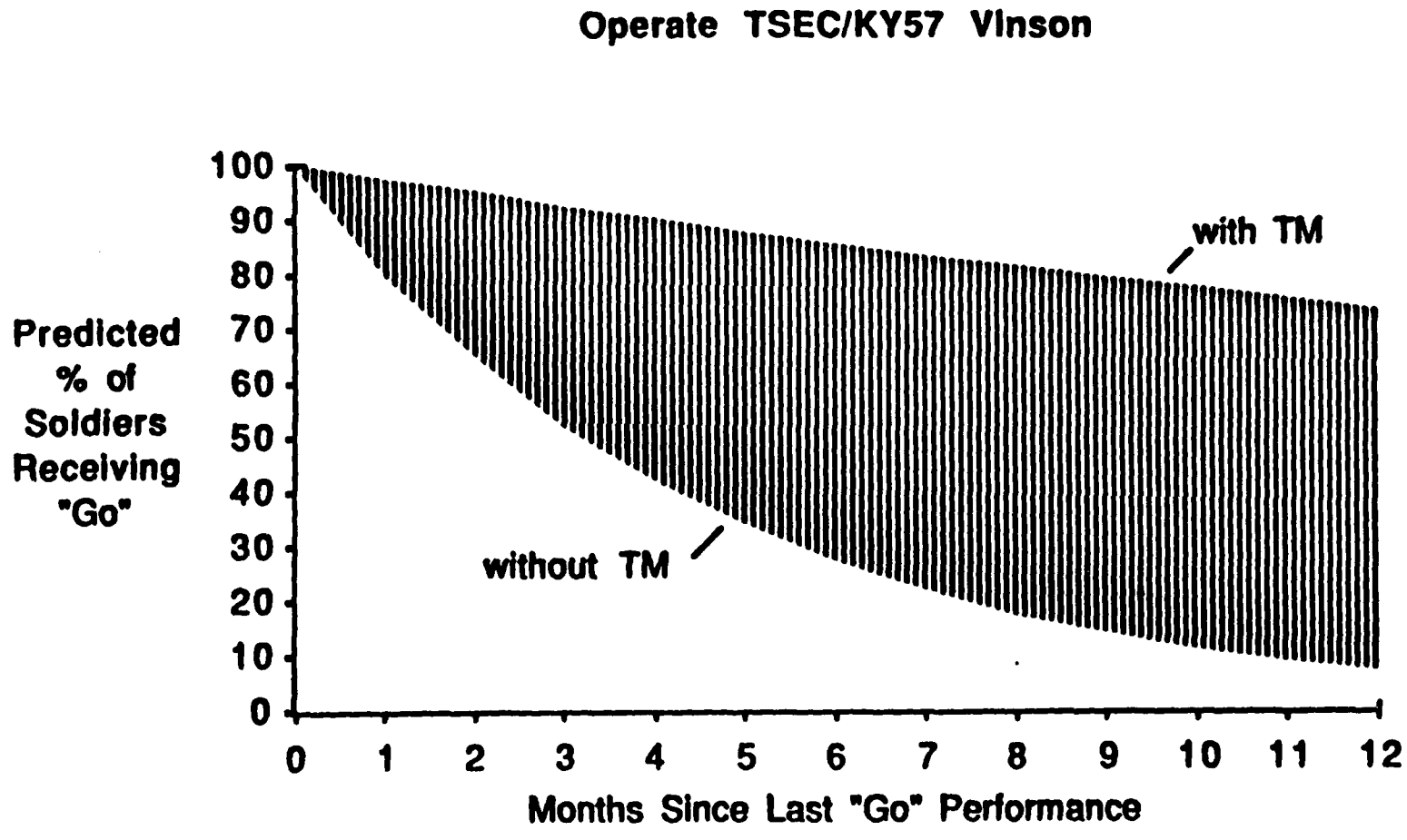


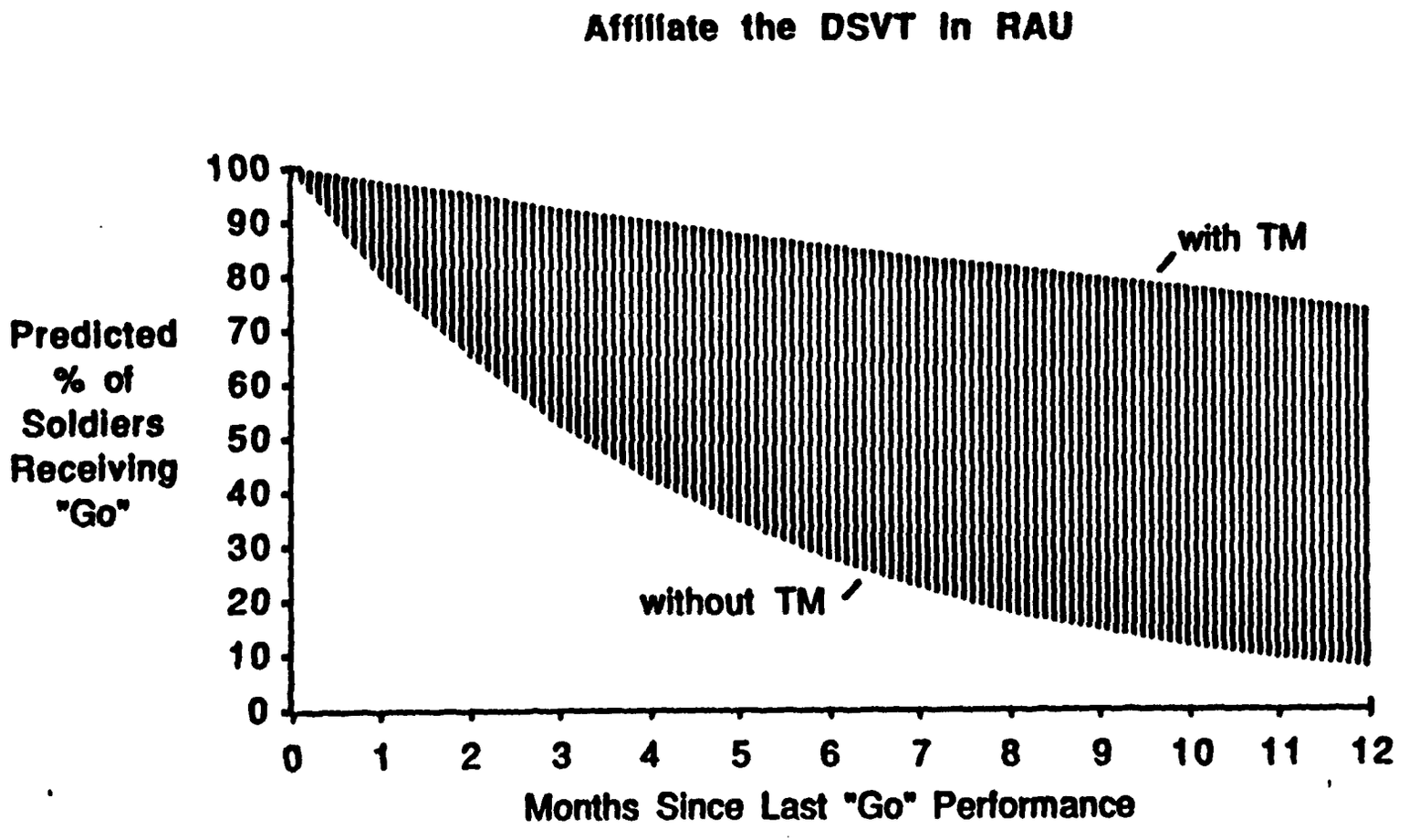
Operate Generator Set PU-751/M

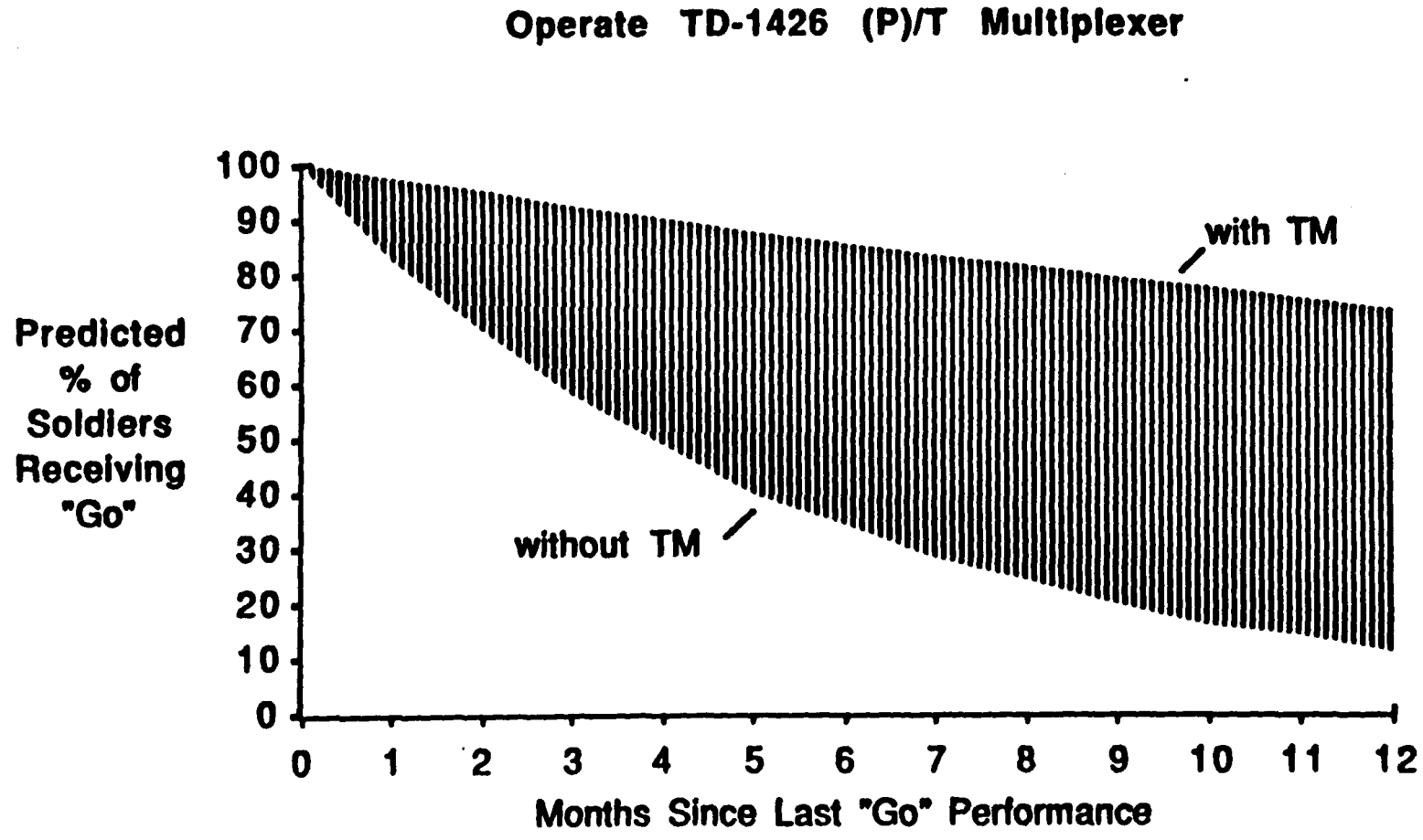


Operate Digital Data Modem MD-1231 (P)/T

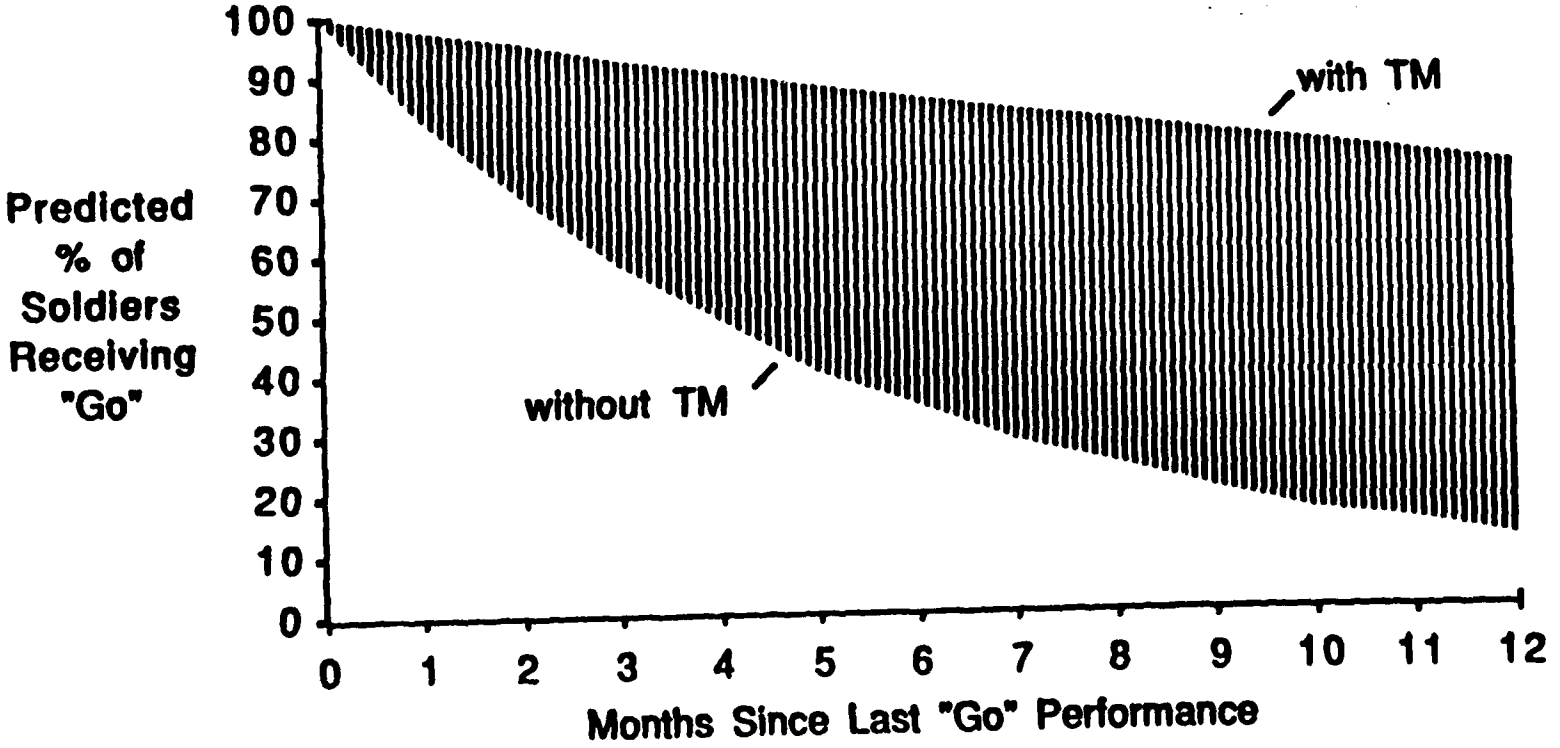



Operate TSEC/KY57 Vinson
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
with TM
without TM
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance

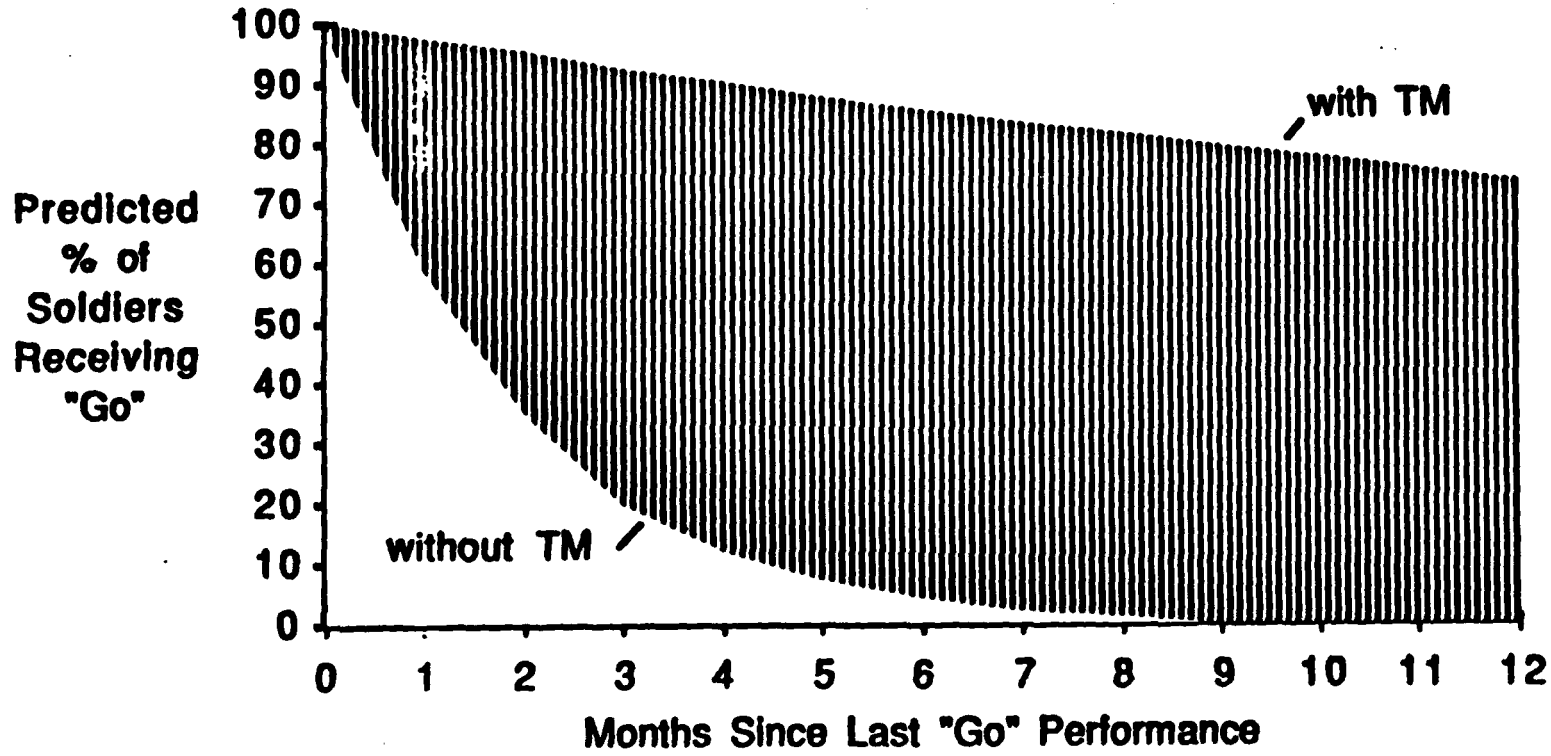

Affiliate the DSVT in RAU
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
with TM
without TM
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance


Operate TD-1426 (P)/T Multiplexer
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
with TM
without TM
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance

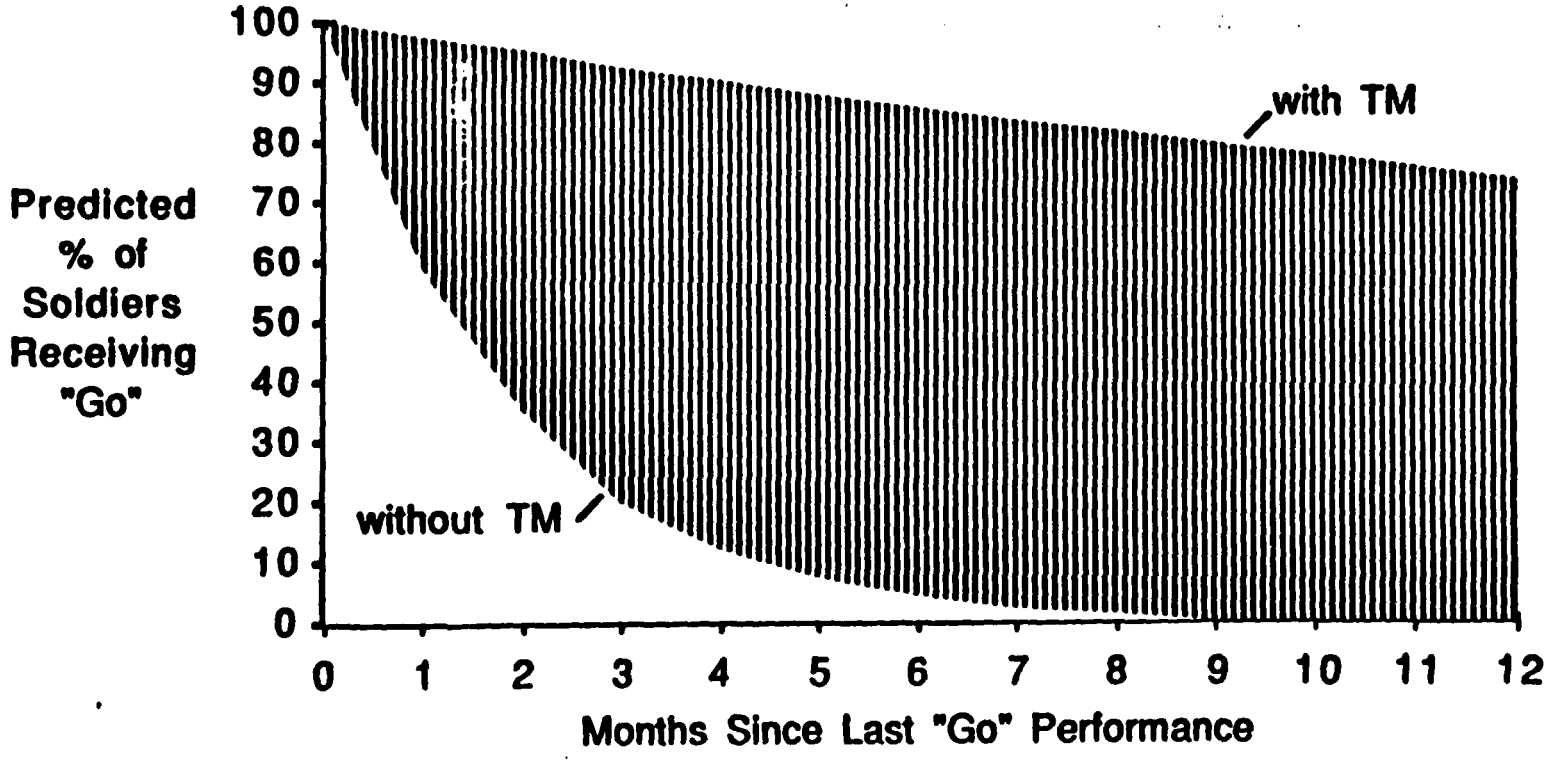
Operate AN/TRC-191 Power Control Panel

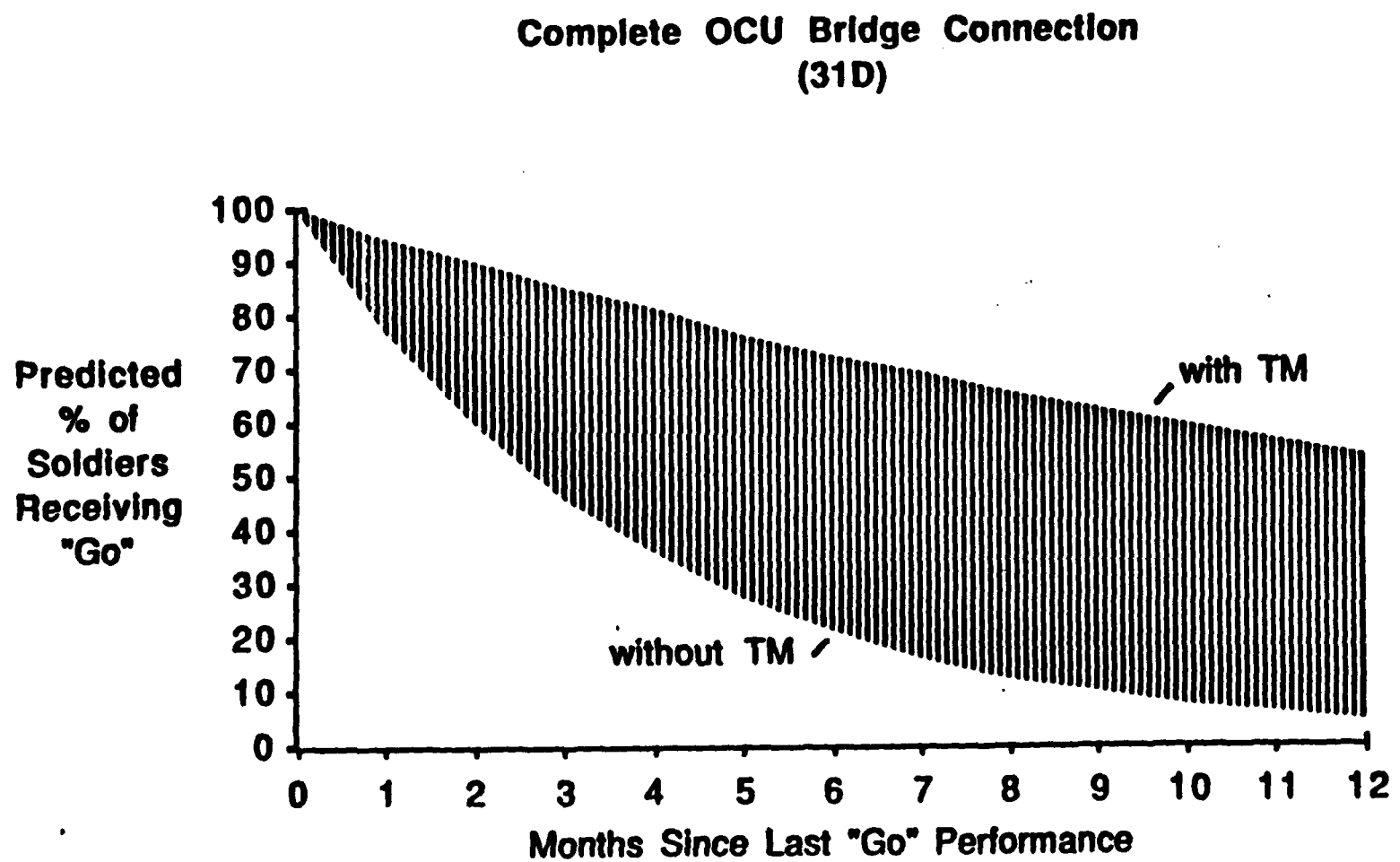


Operate AN/TRC-190 (V) Circuit Breaker Panel

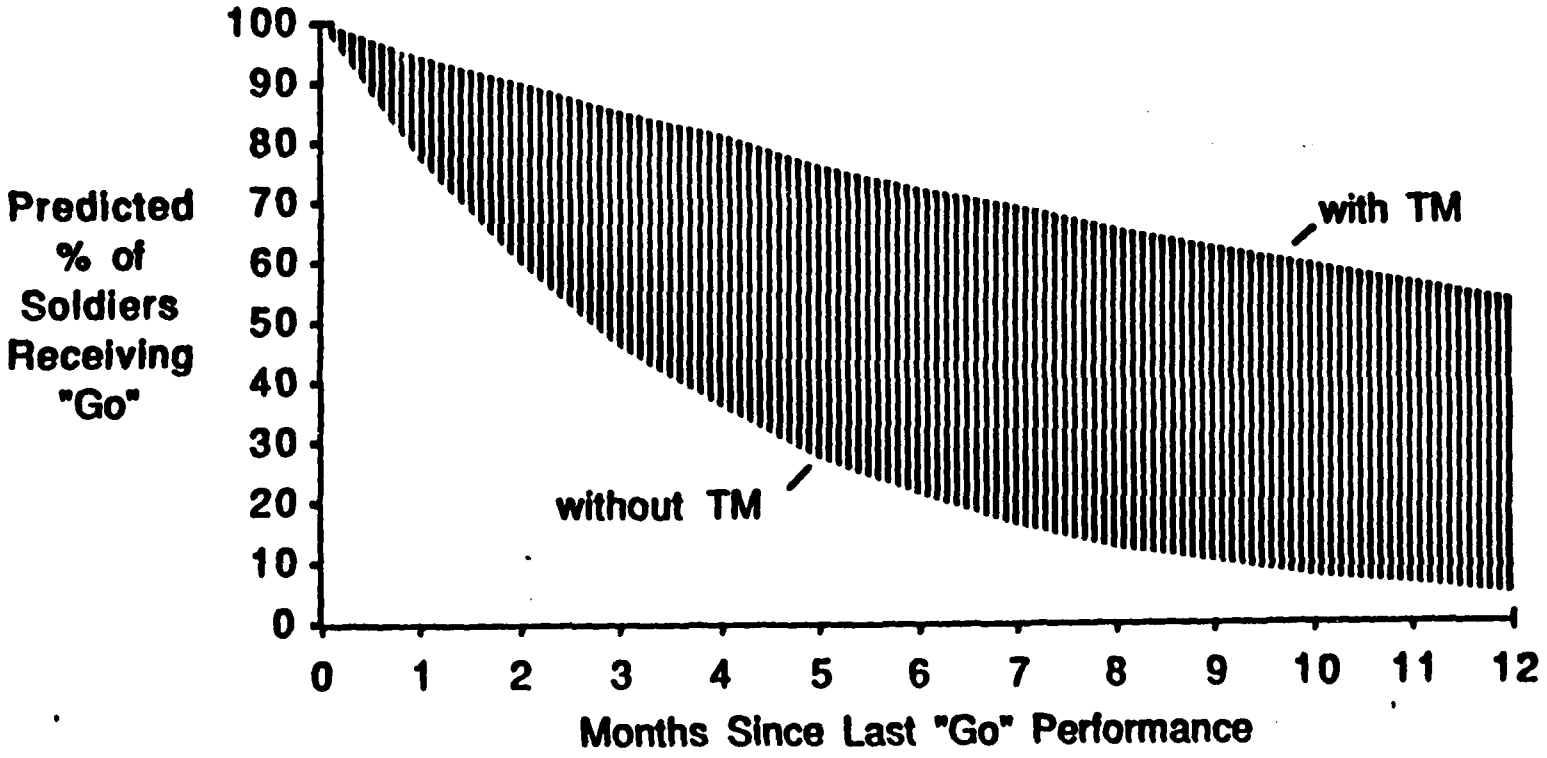


Operate C-11878/T Orderwire Control Unit (OCU)

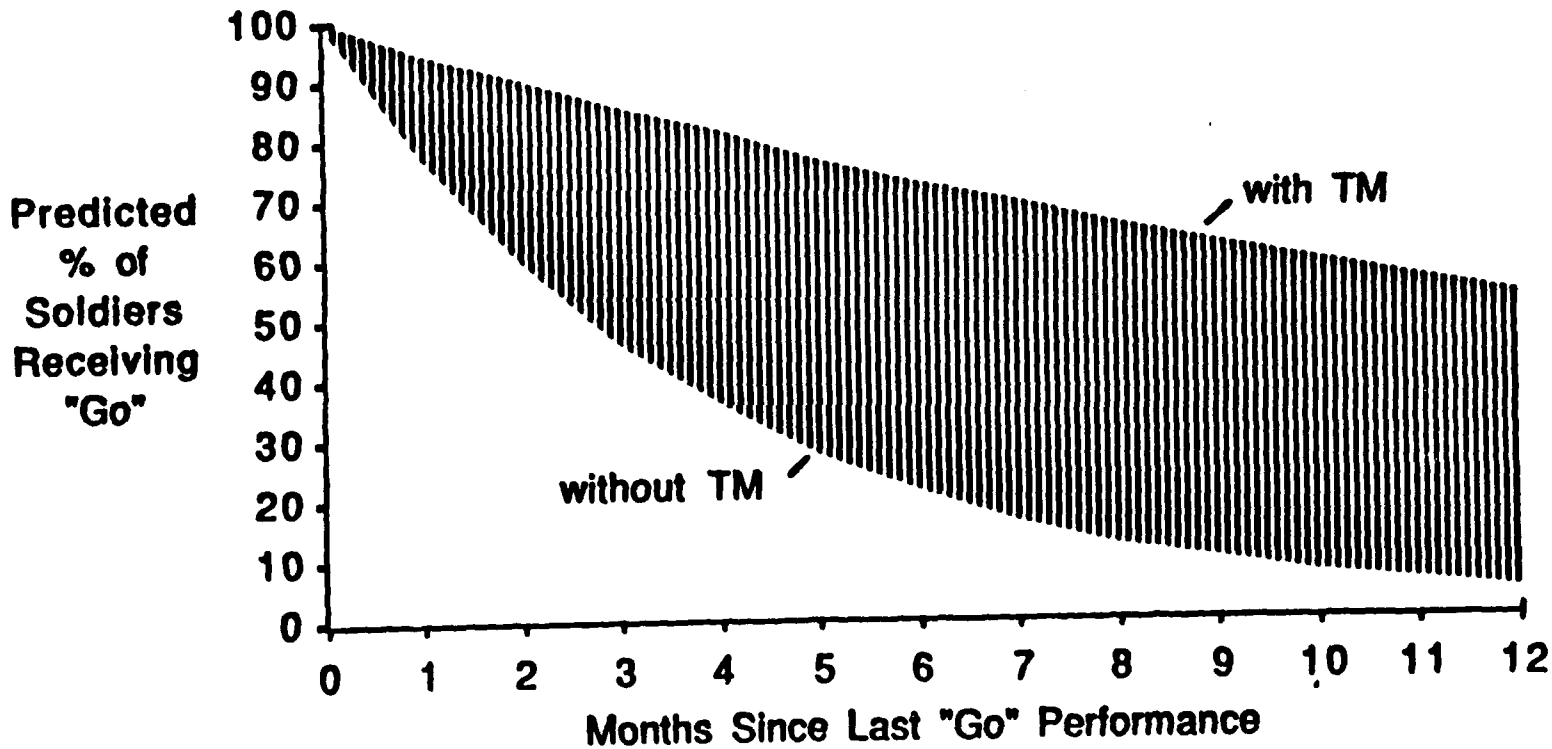



Complete OCU Bridge Connection
(31D)
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
with TM
without TM
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance

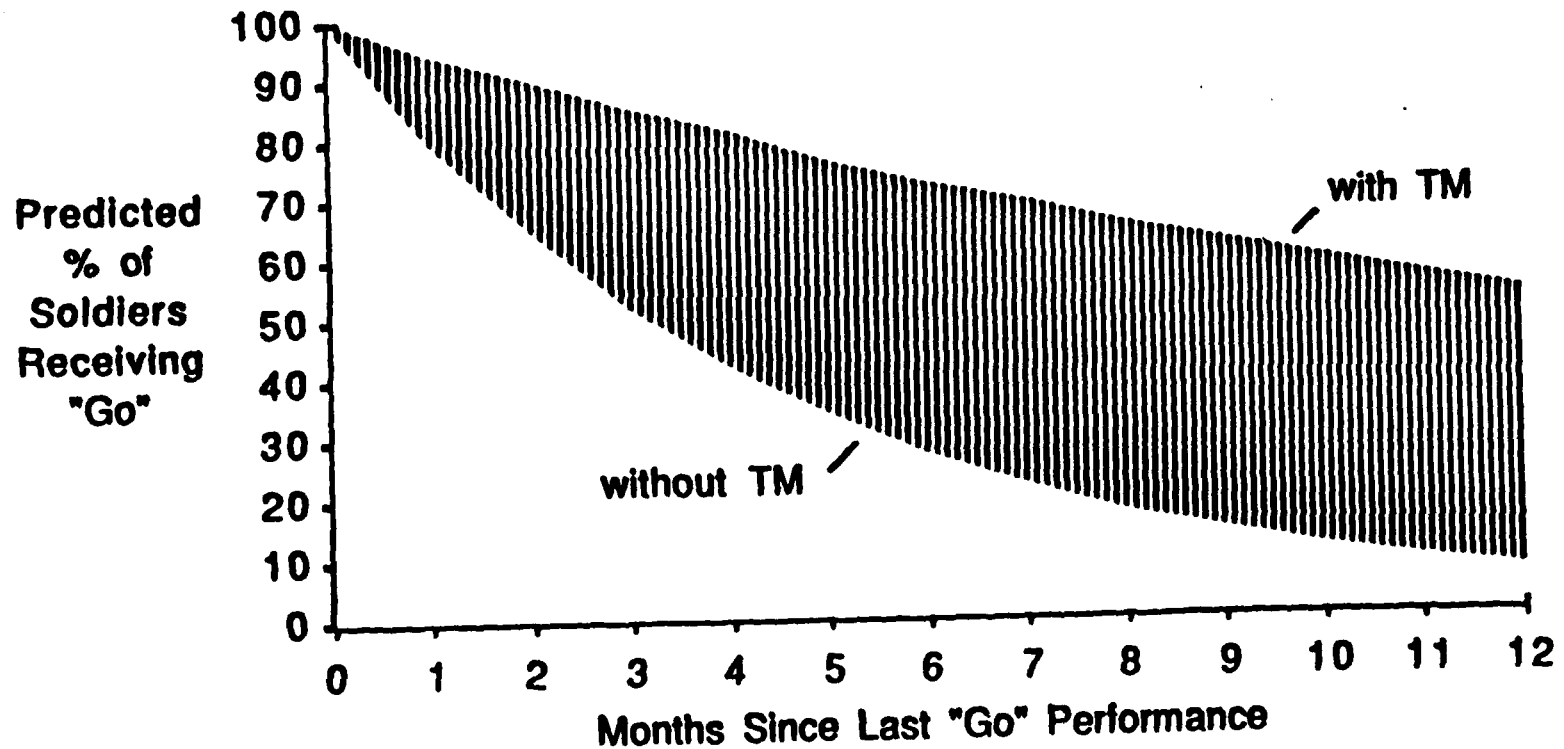
Affiliate an MSRT to RAU



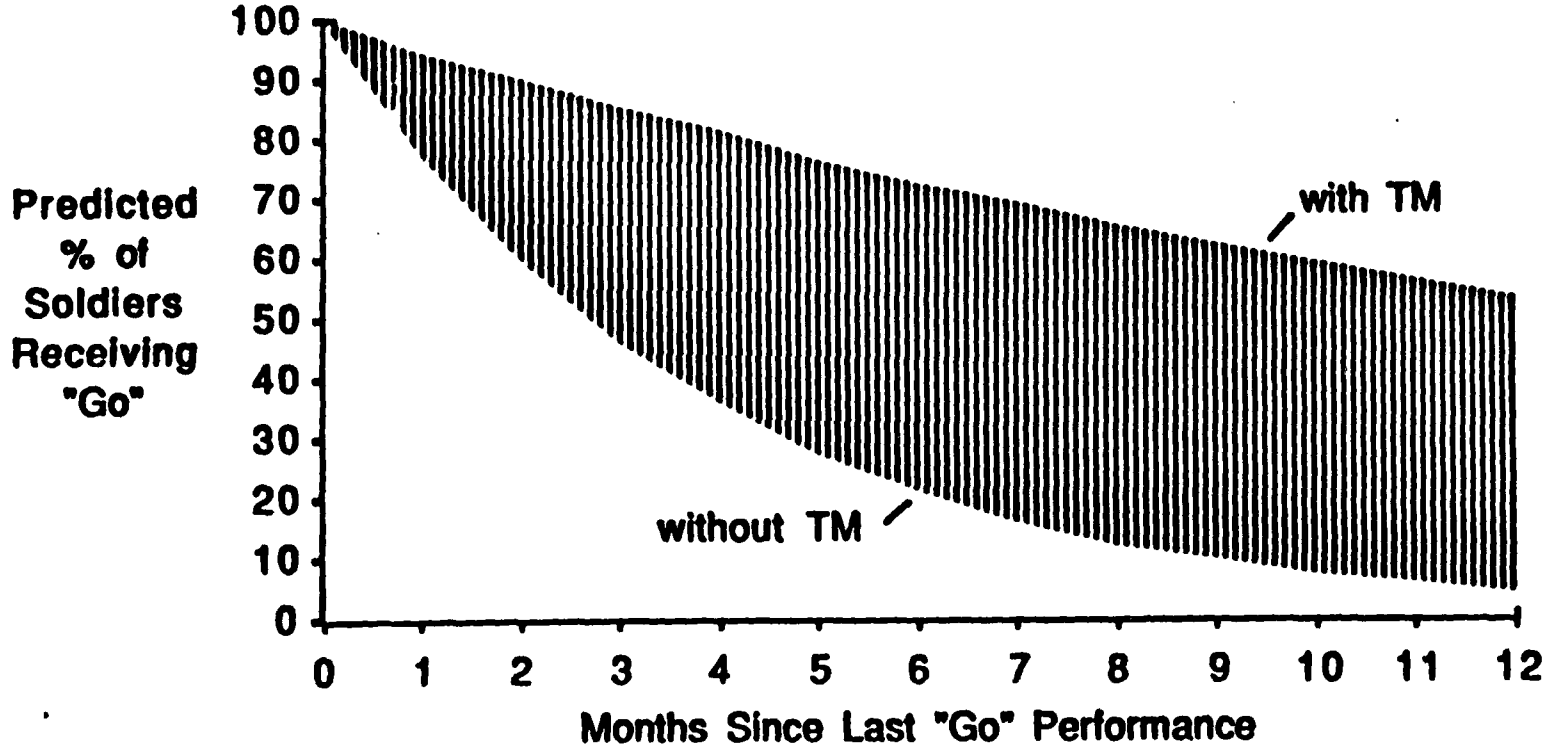
Electronically Download a Frequency Plan to an MSRT



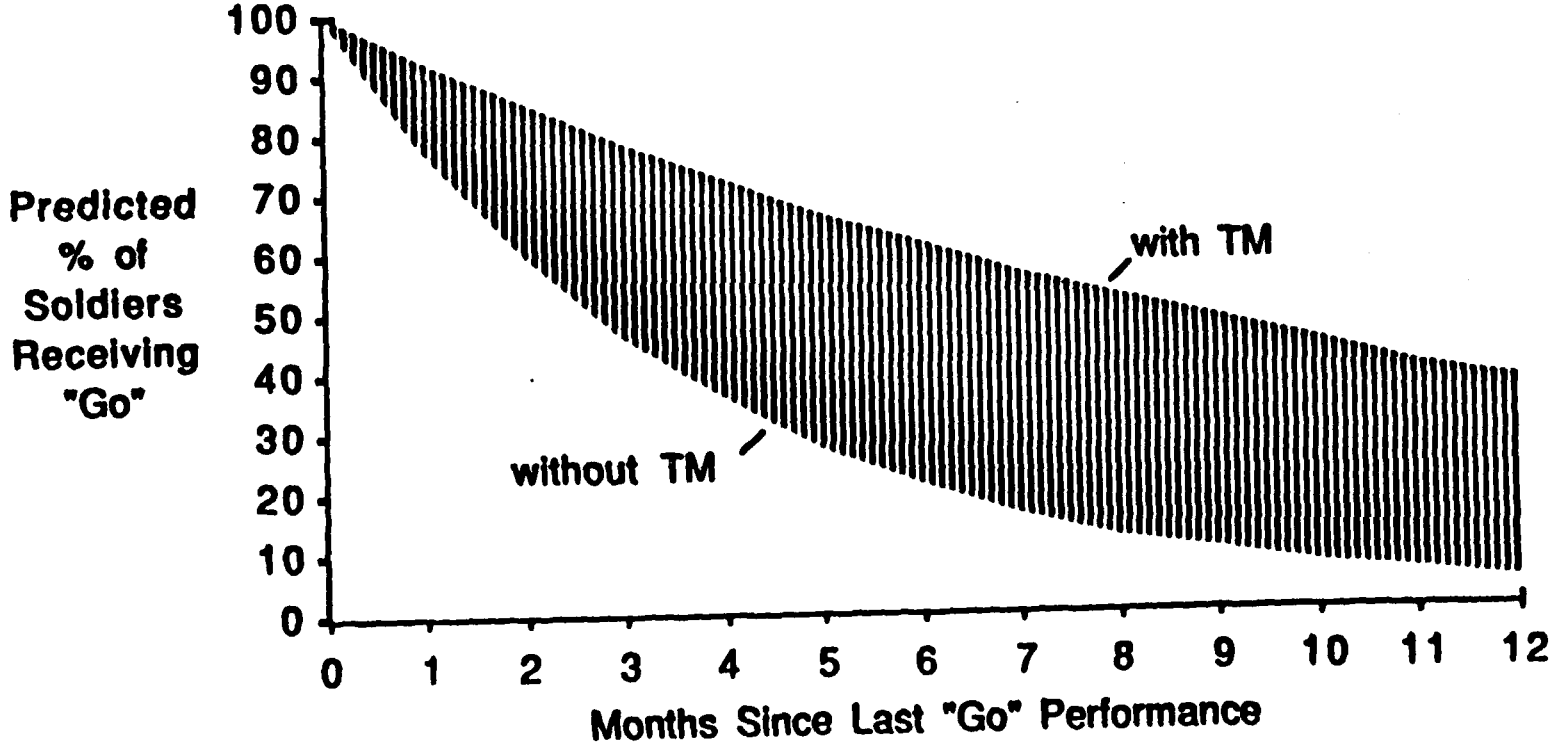
Operate Radio Set AN/GRC-226 (V)



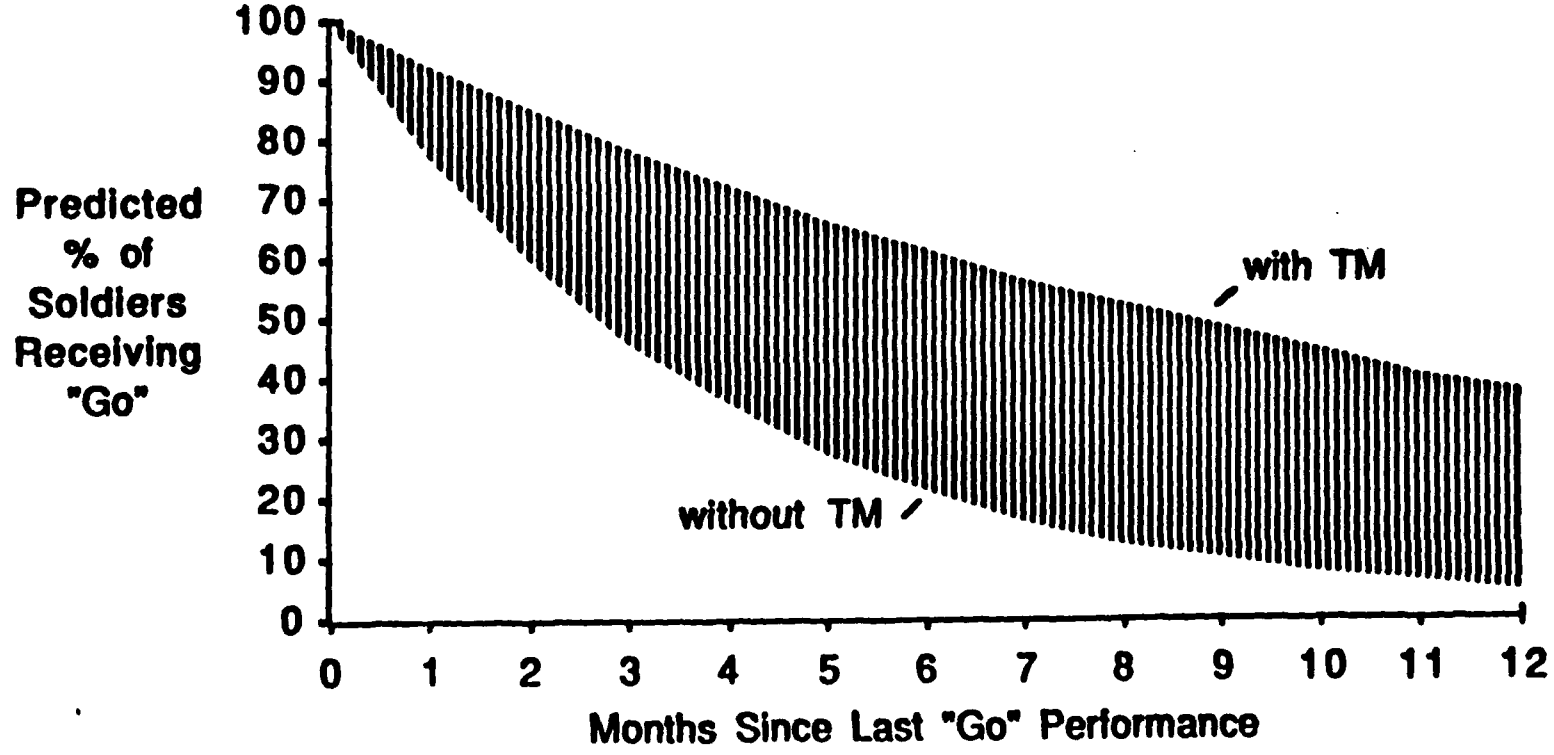
Place a Call Using OCU (31D)



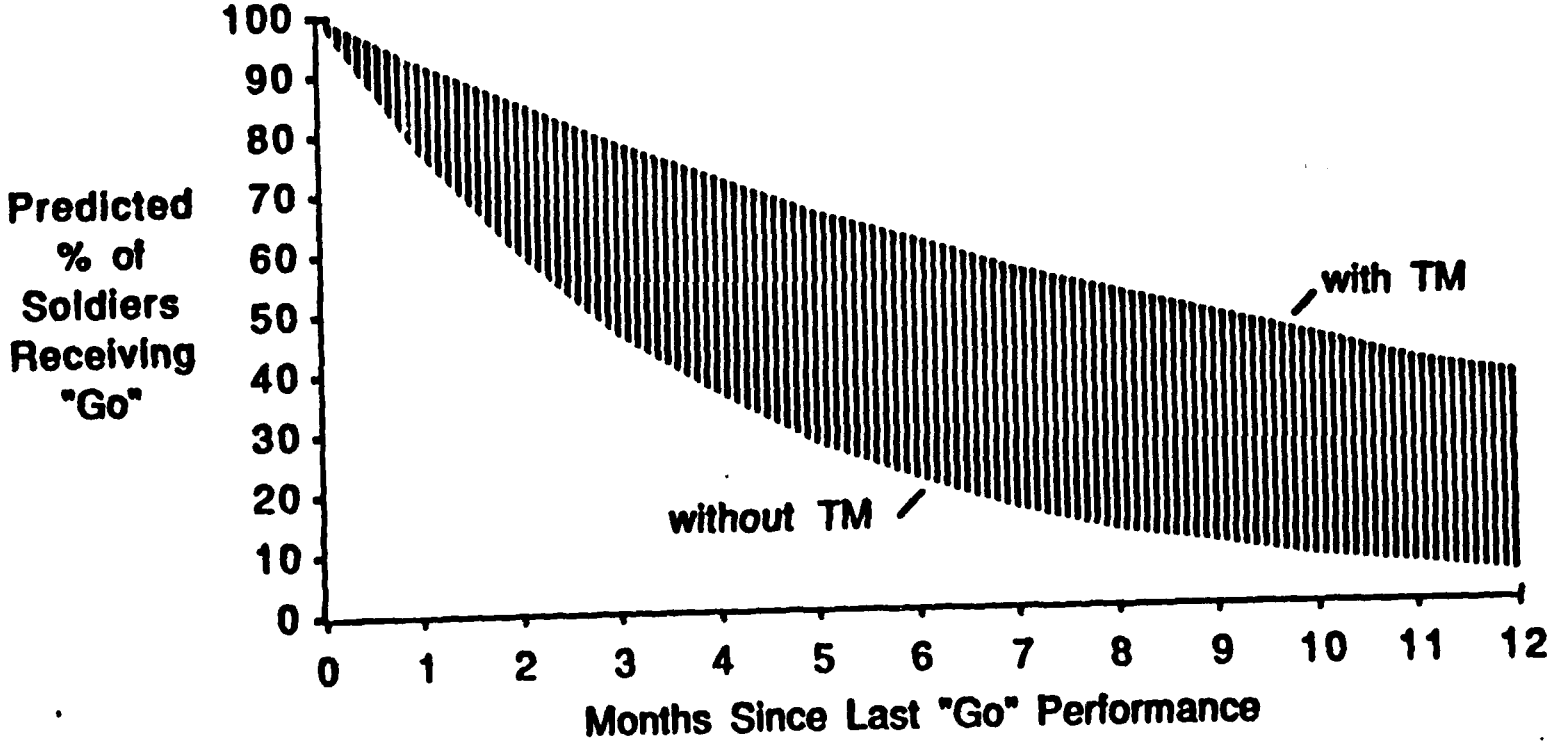
Operate C-LL865/TRC-191 Receiver-Transmitter Controller

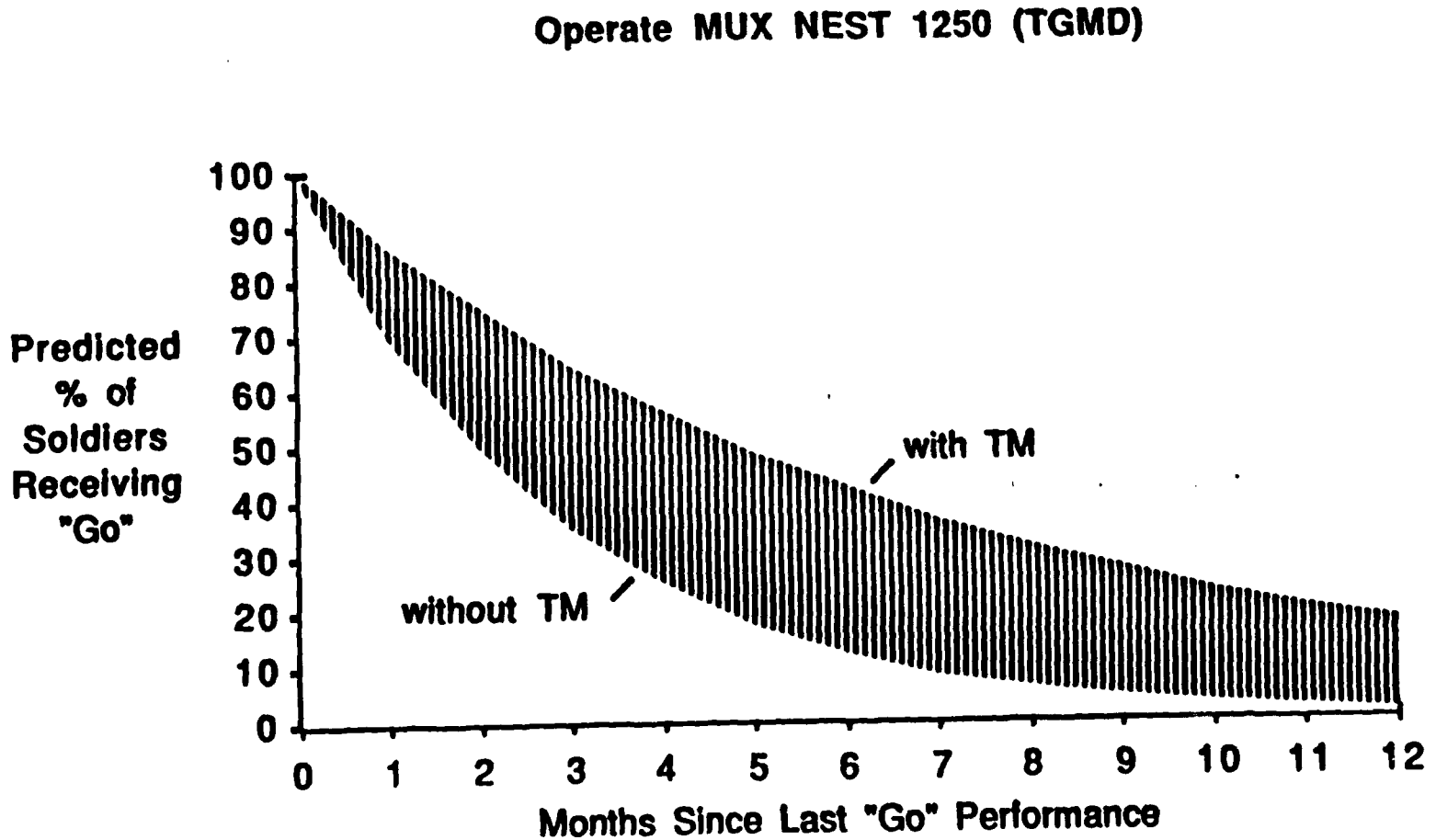


Manually Load Frequency Plan (31D)

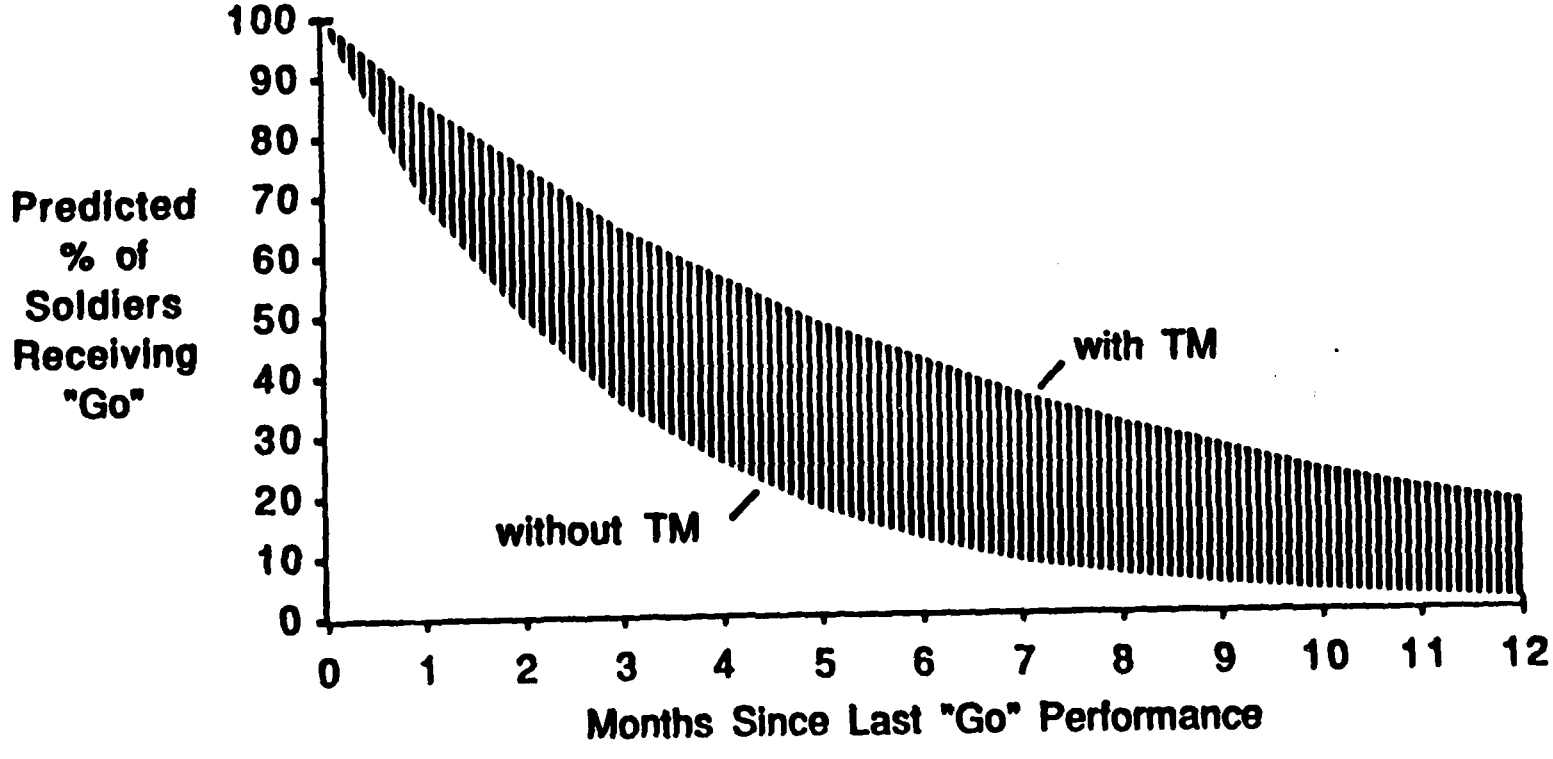


Load COMSEC Keys Into RT 1539

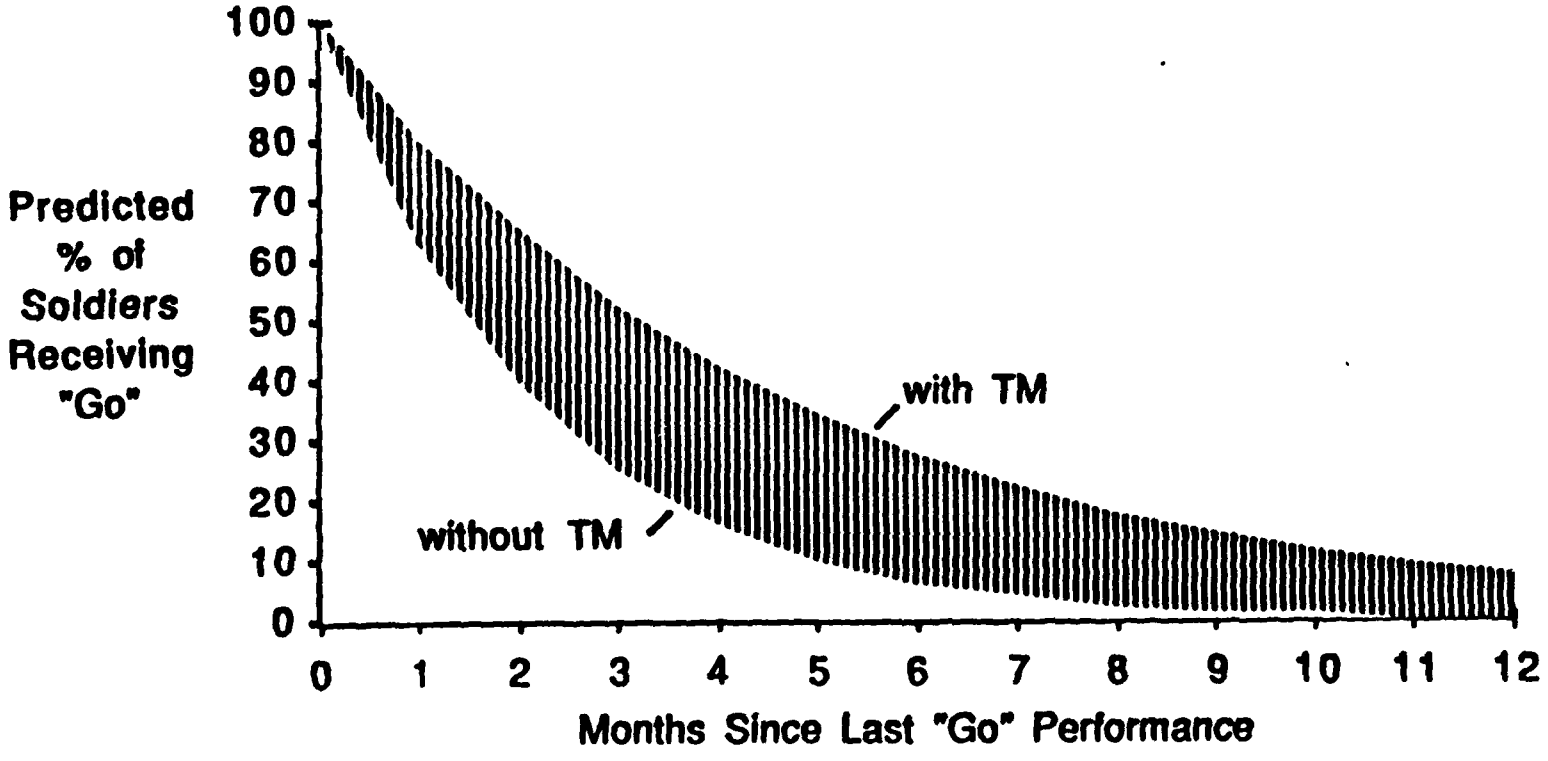



Operate MUX NEST 1250 (TGMD)
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
with TM
without TM
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance

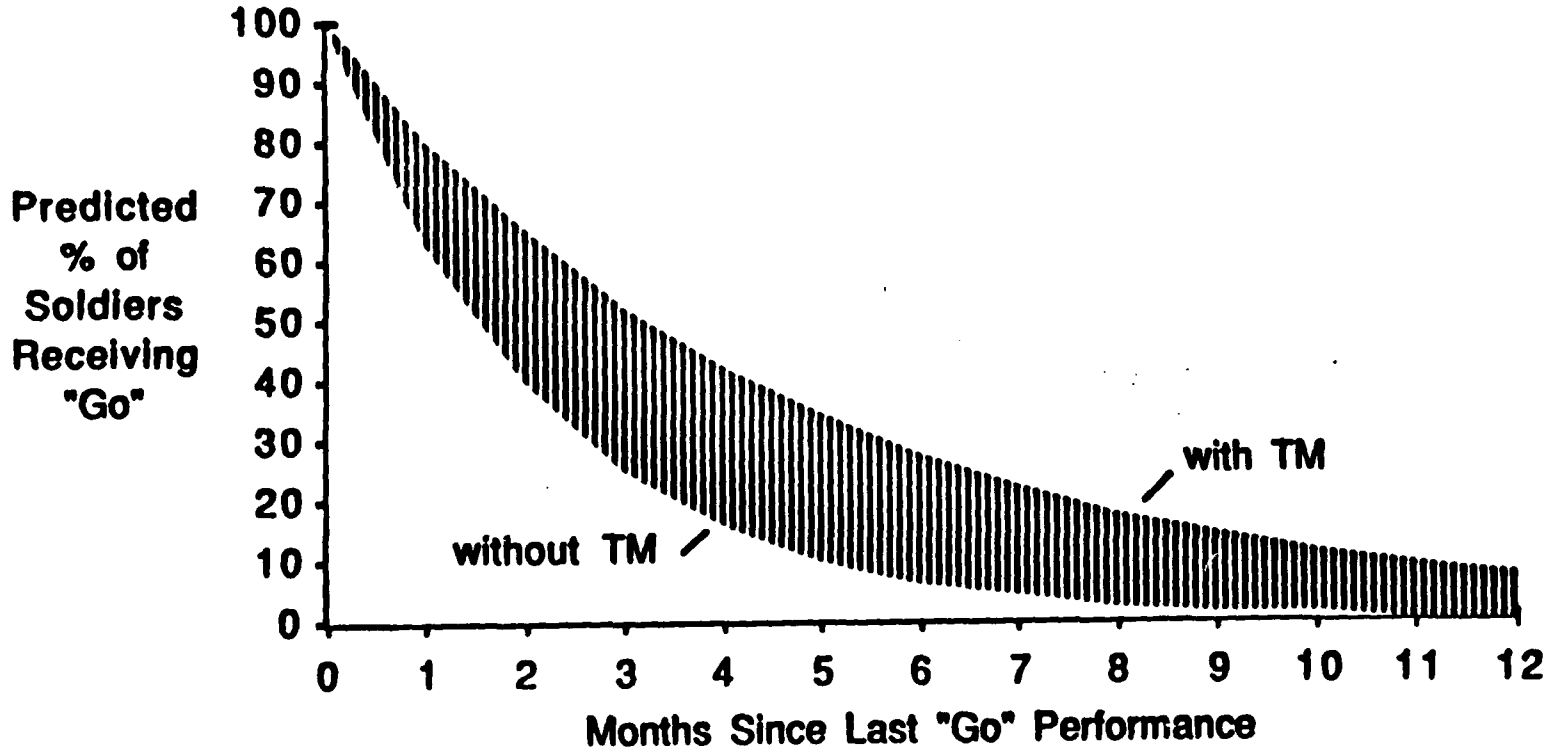
Operate CV-4002/G NATO Analog Interface Converter



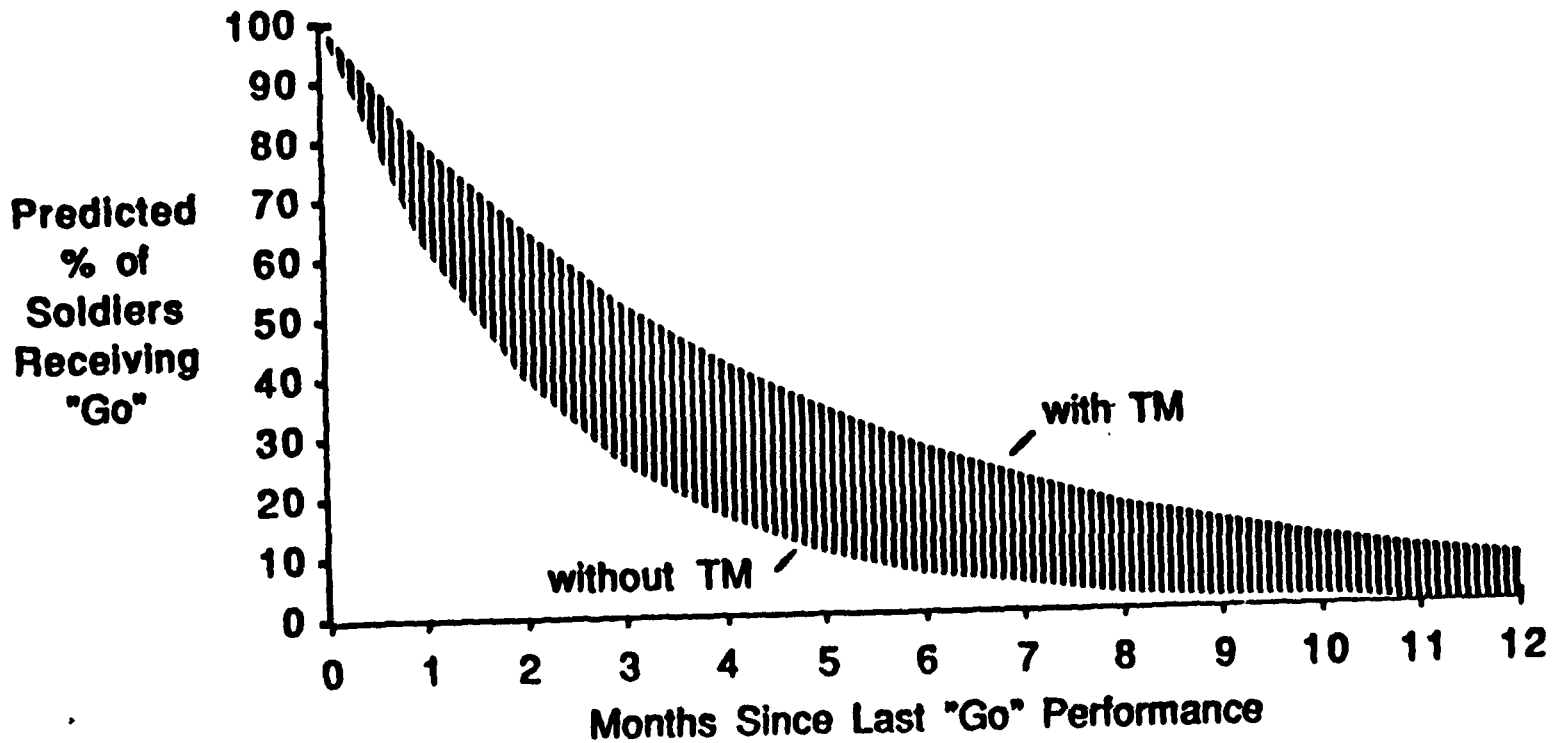
Configure AN/TRC-191 for MSRT Operations



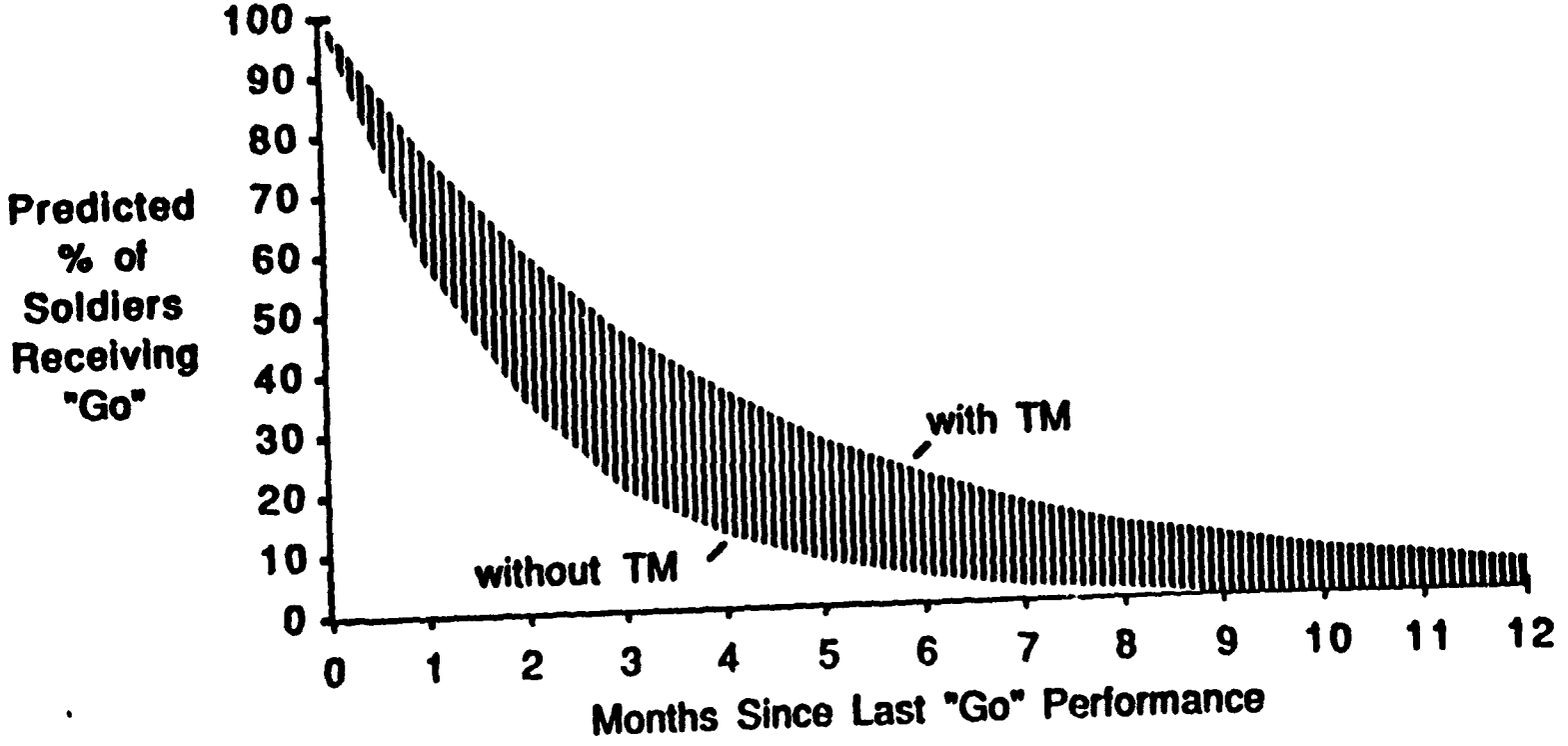
Operate Radio Set AN/GRC-224



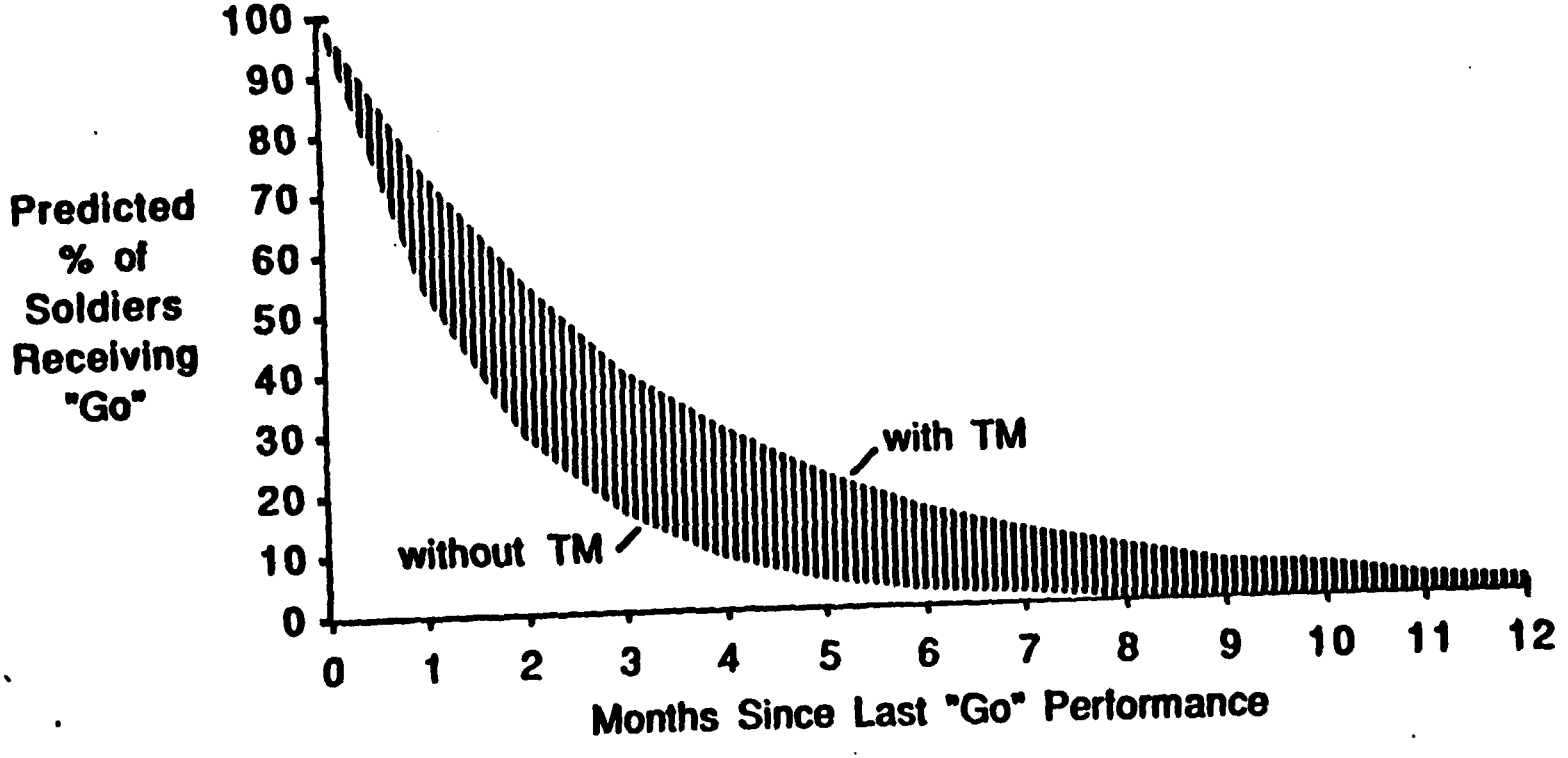
Receive Over-the-Air Rekey (OTAR) (31D)



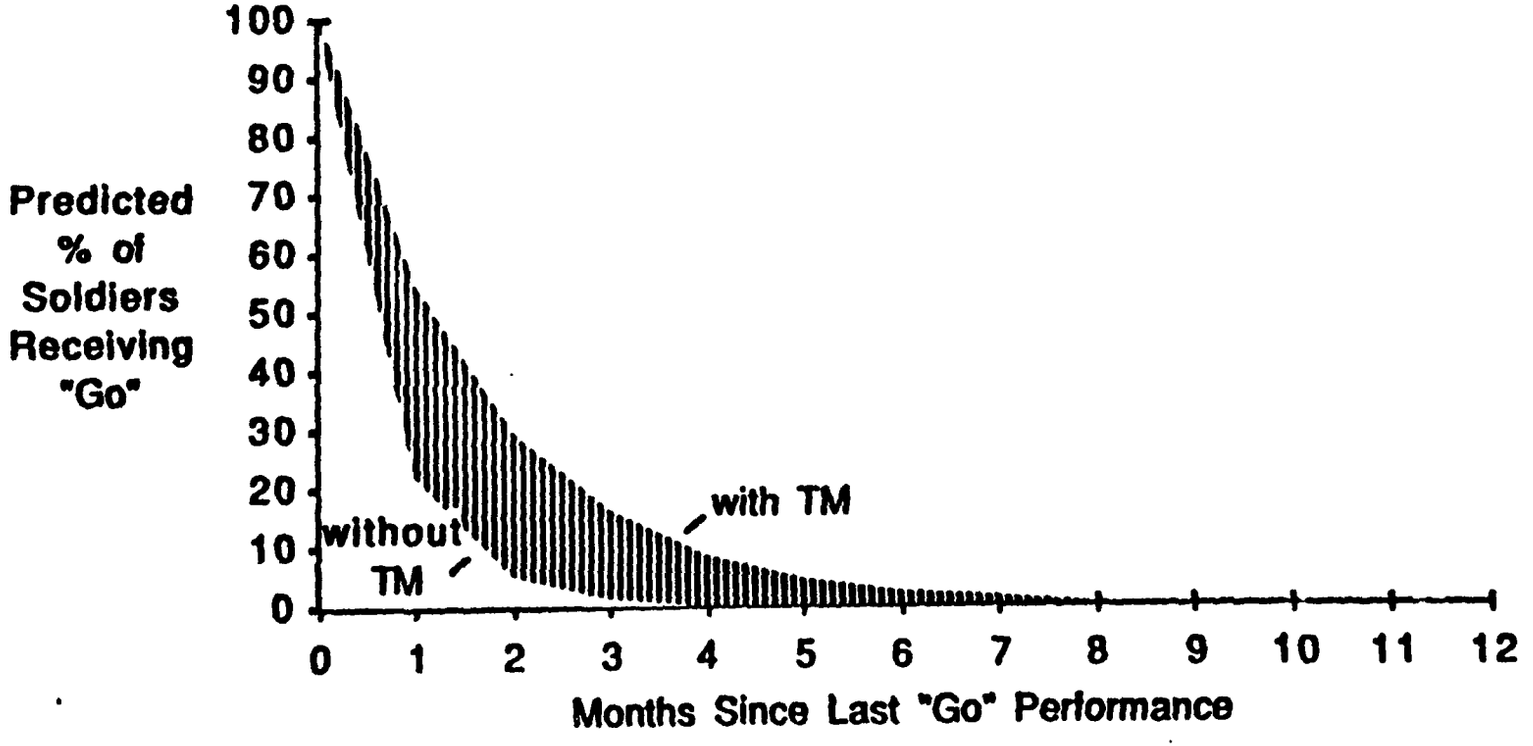
Initialize Line-of-Sight (LOS) Radio

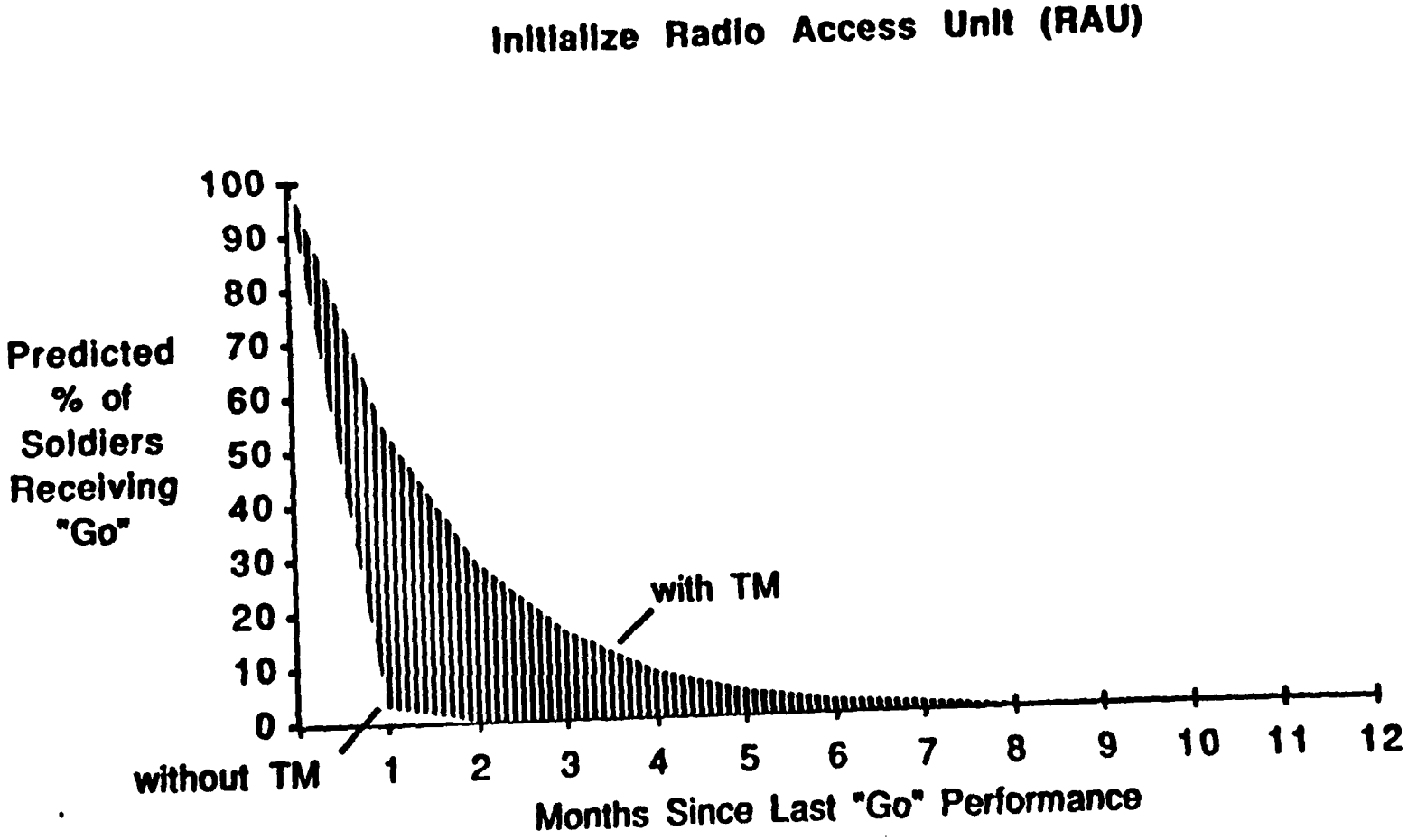


Affiliate Group Logic Unit (GLU)



Reconfigure RAU as an MSRT




Initialize Radio Access Unit (RAU)
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
with TM
without TM
1
2
3
4
5
6
7
8
9
10
11
12
Months Since Last "Go" Performance

APPENDIX B

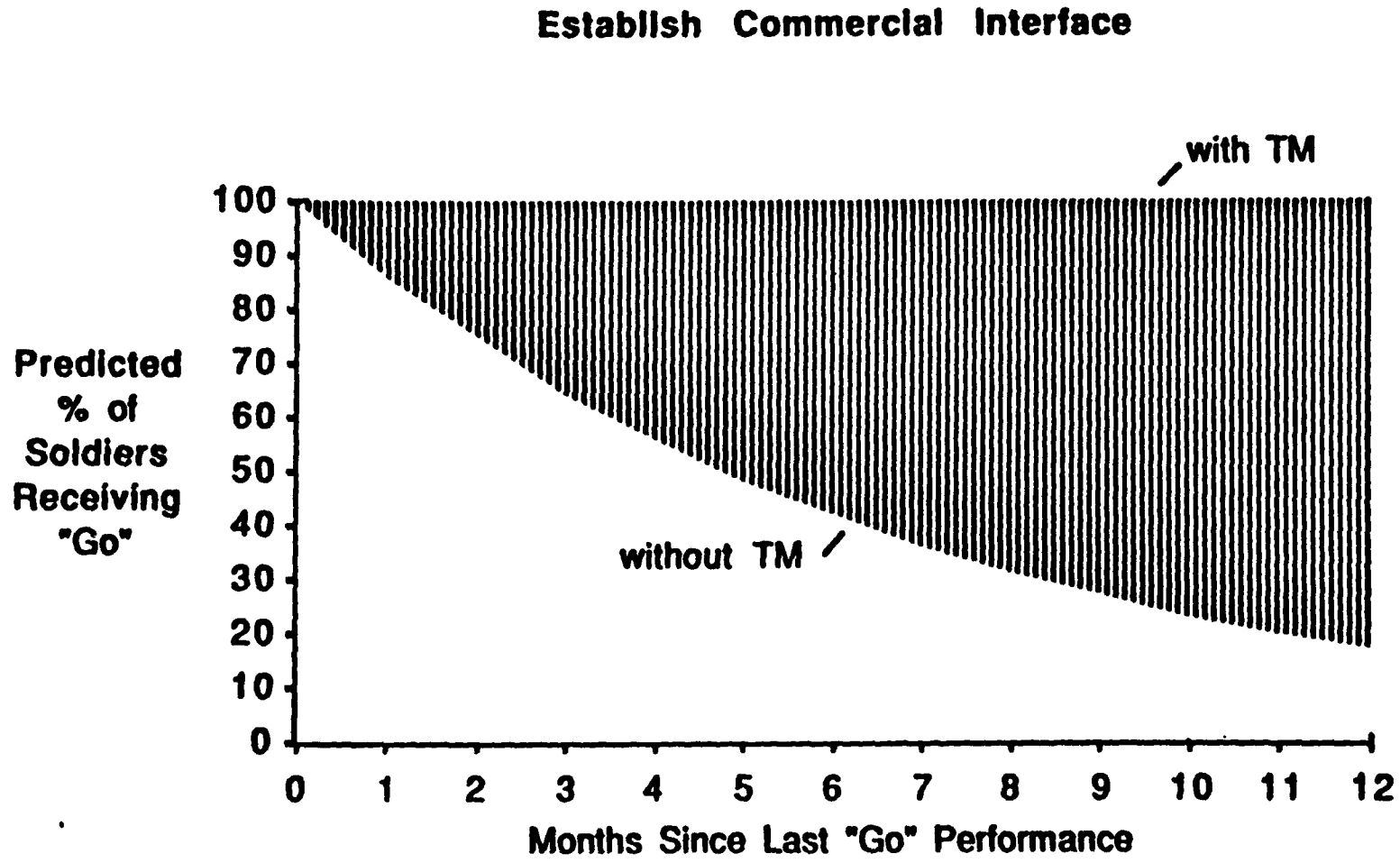
MOS 31F Procedures

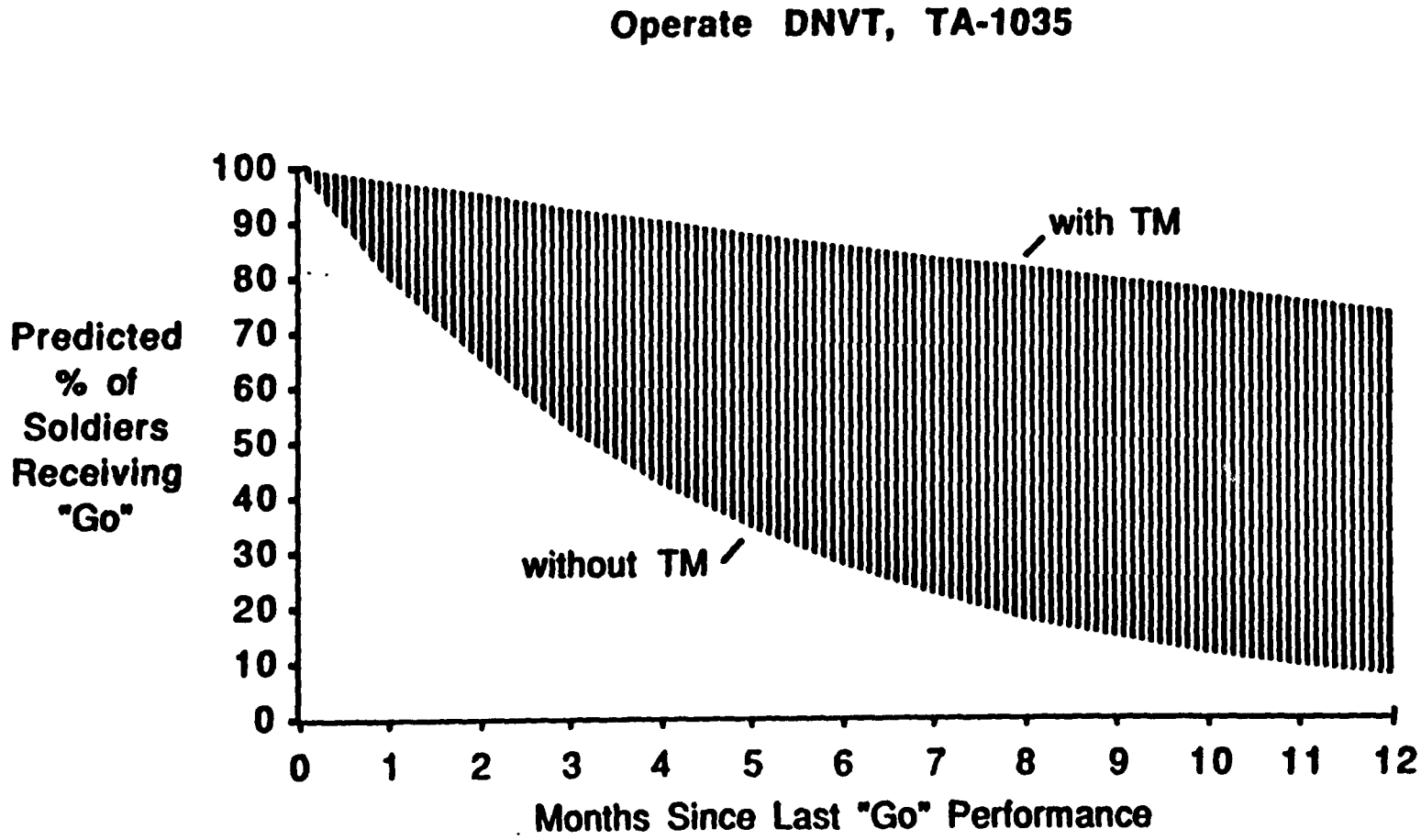
Well-retained:

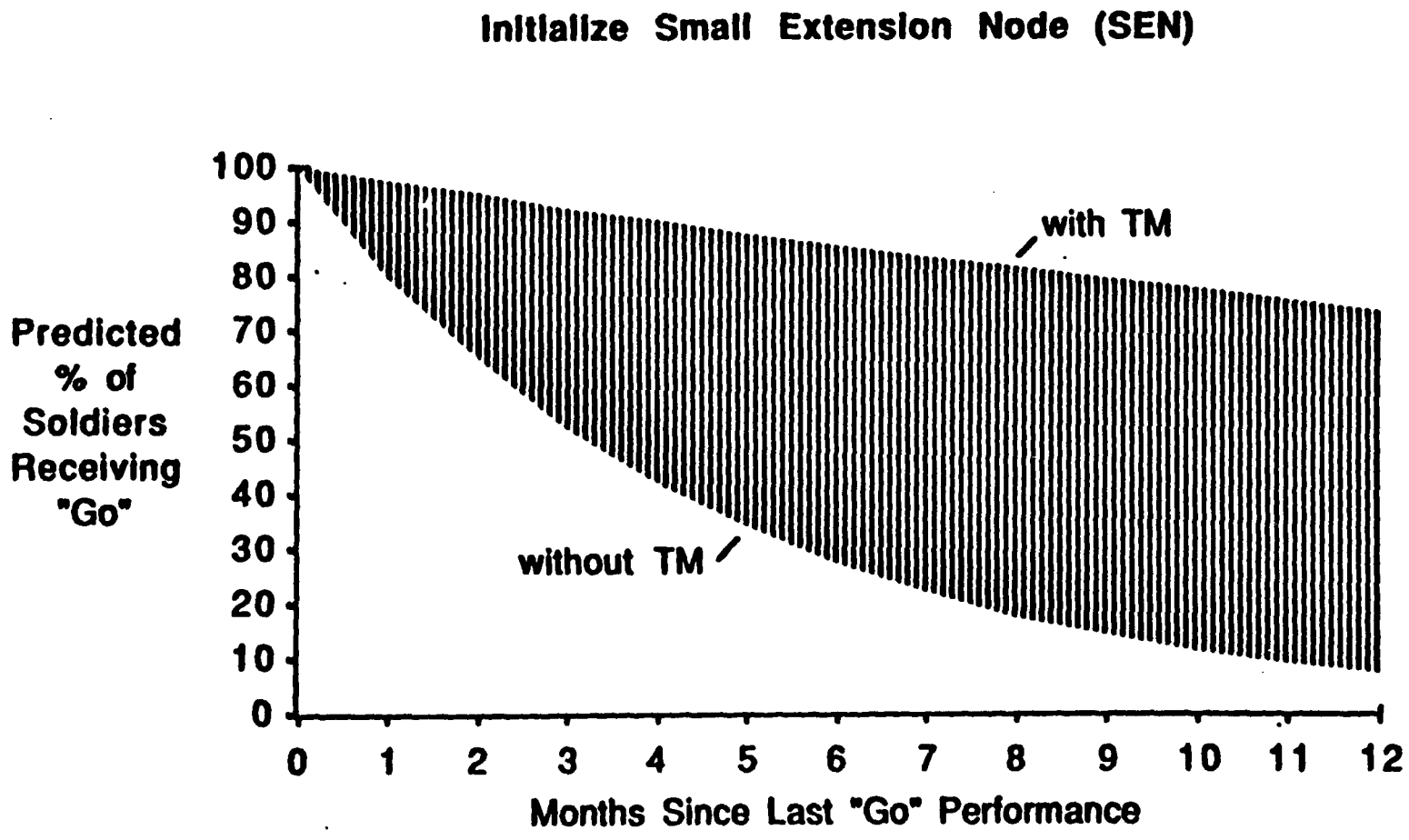
Moderately-retained:

APPENDIX B

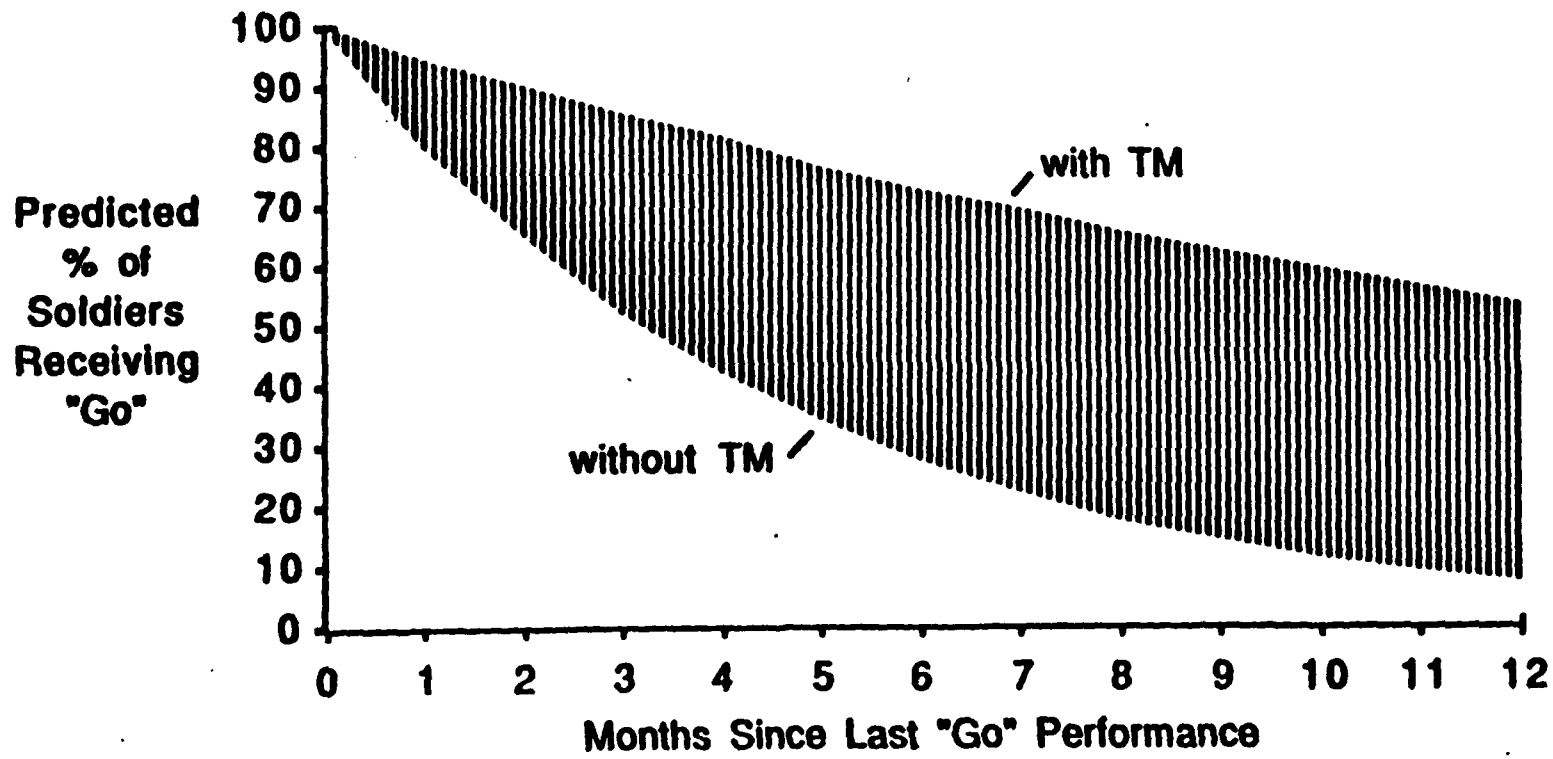
MOS 31F Procedures (continued)


Establish Commercial Interface
with TM
without TM
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance

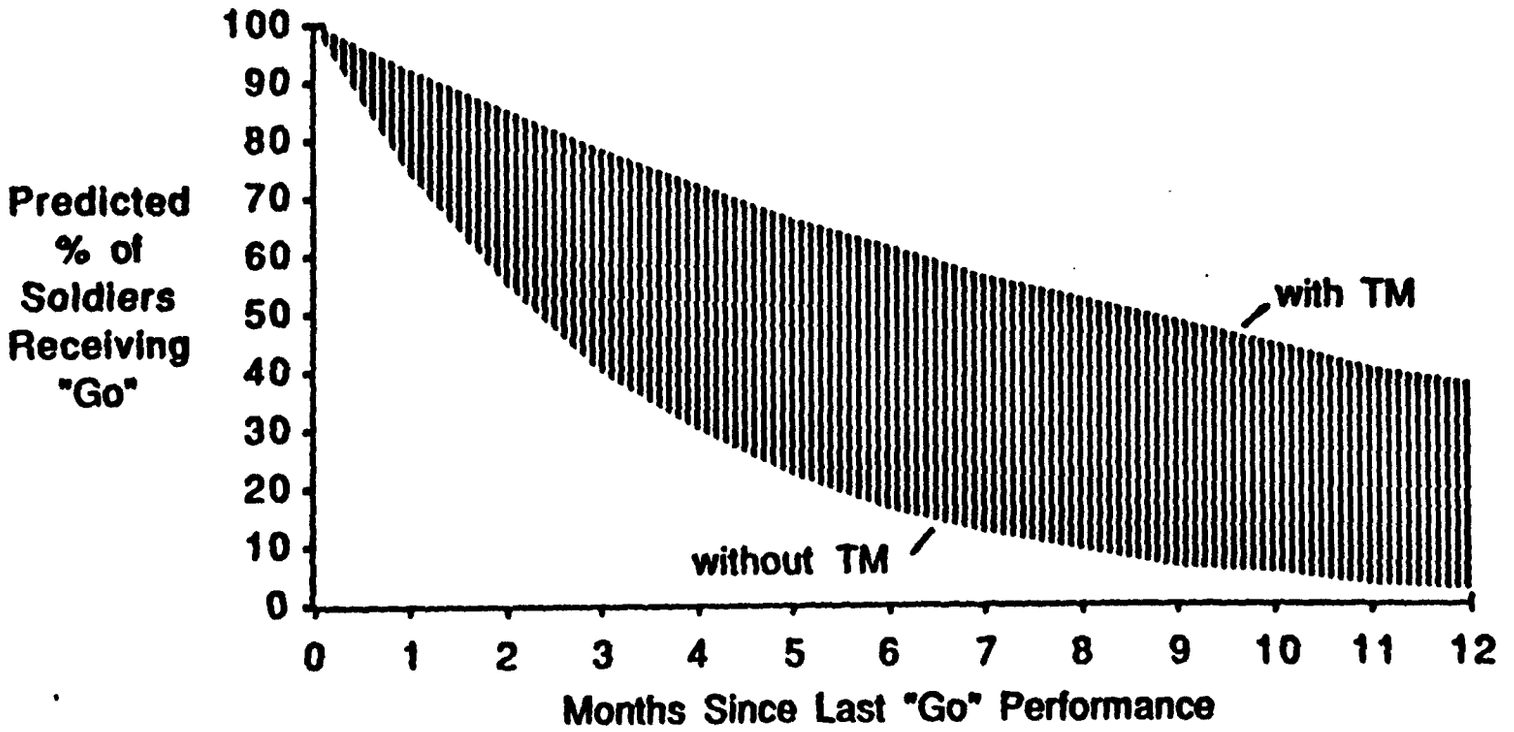

Operate DNVT, TA-1035
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
with TM
without TM
0 1 2 3 4 5 6 7 8 9 10 11 12
Months Since Last "Go" Performance


Initialize Small Extension Node (SEN)
Predicted % of Soldiers Receiving "Go"
100
90
80
70
60
50
40
30
20
10
0
with TM
without TM
0
1
2
3
4
5
6
7
8
9
10
11
12
Months Since Last "Go" Performance

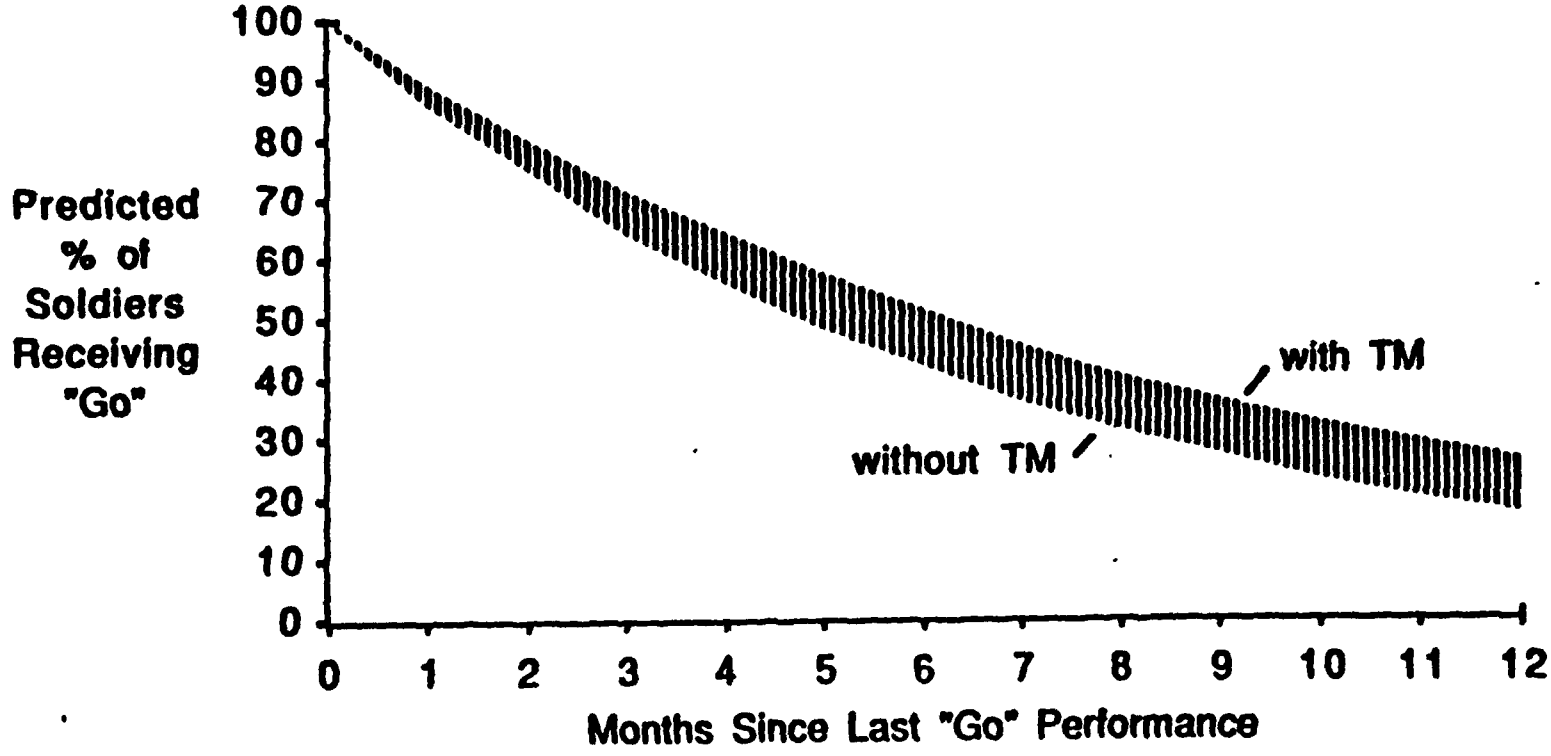
Operate Generator Set PU-753/M



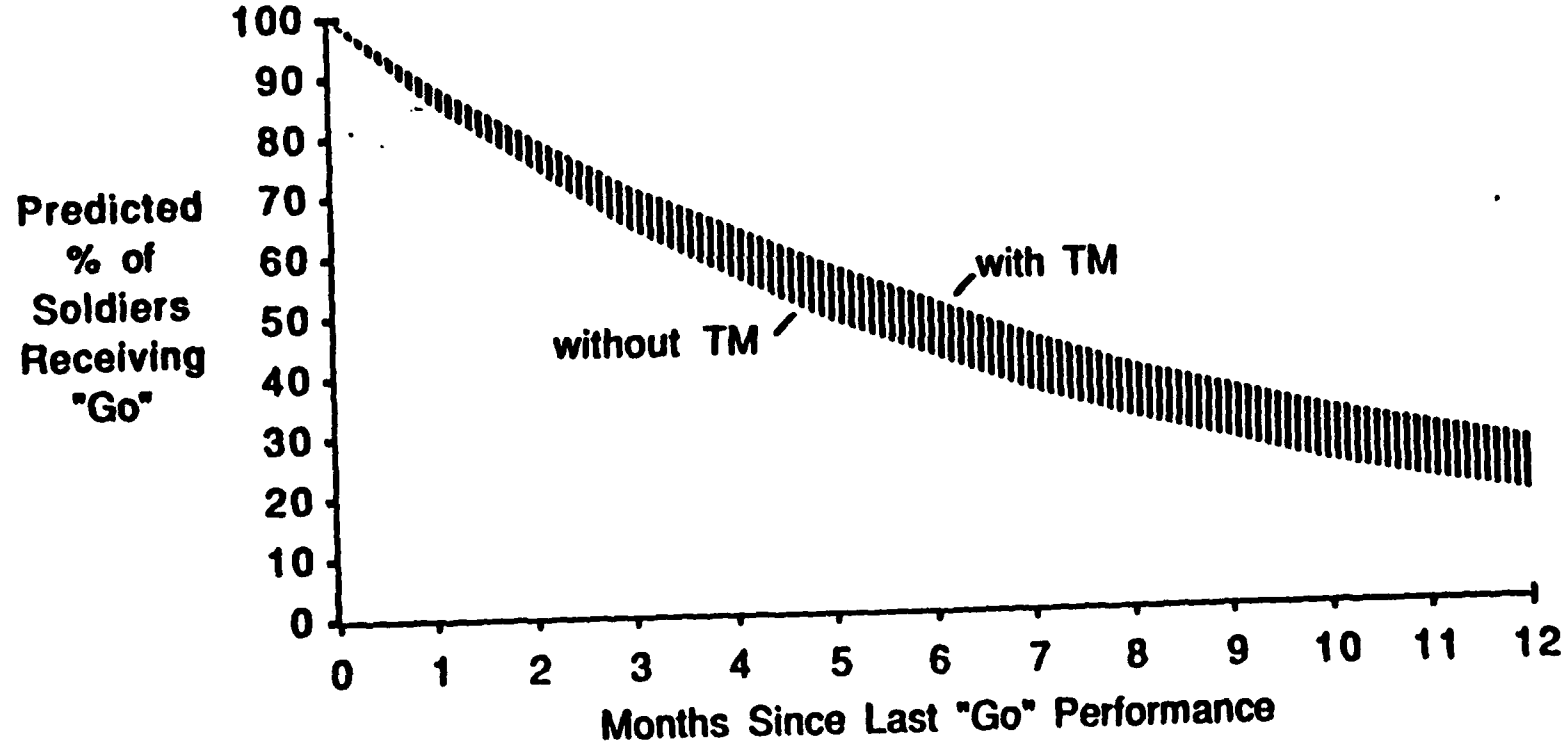
Receive Over-the-Air Rekey (OTAR)



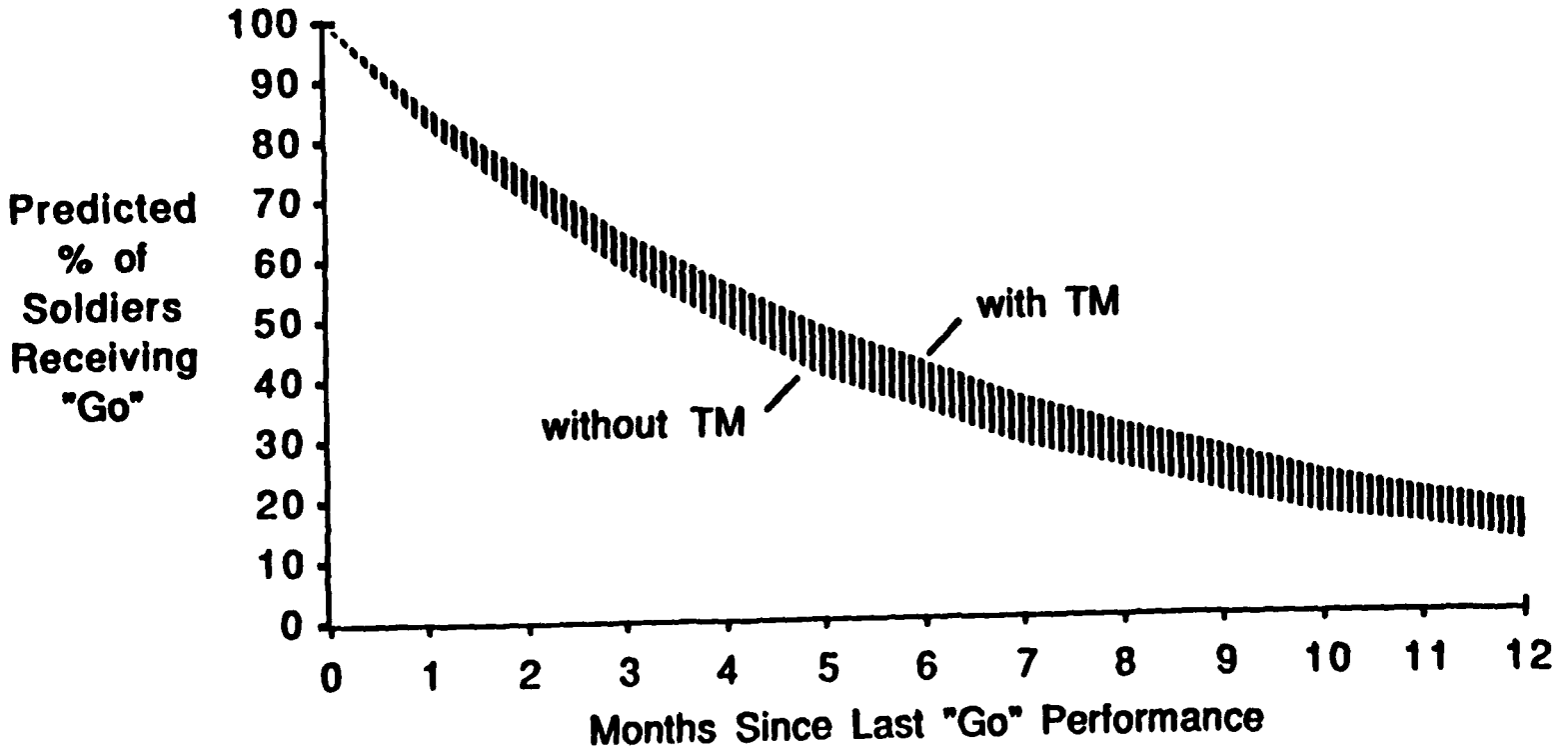
Send Over-the-Air Rekey (OTAR)



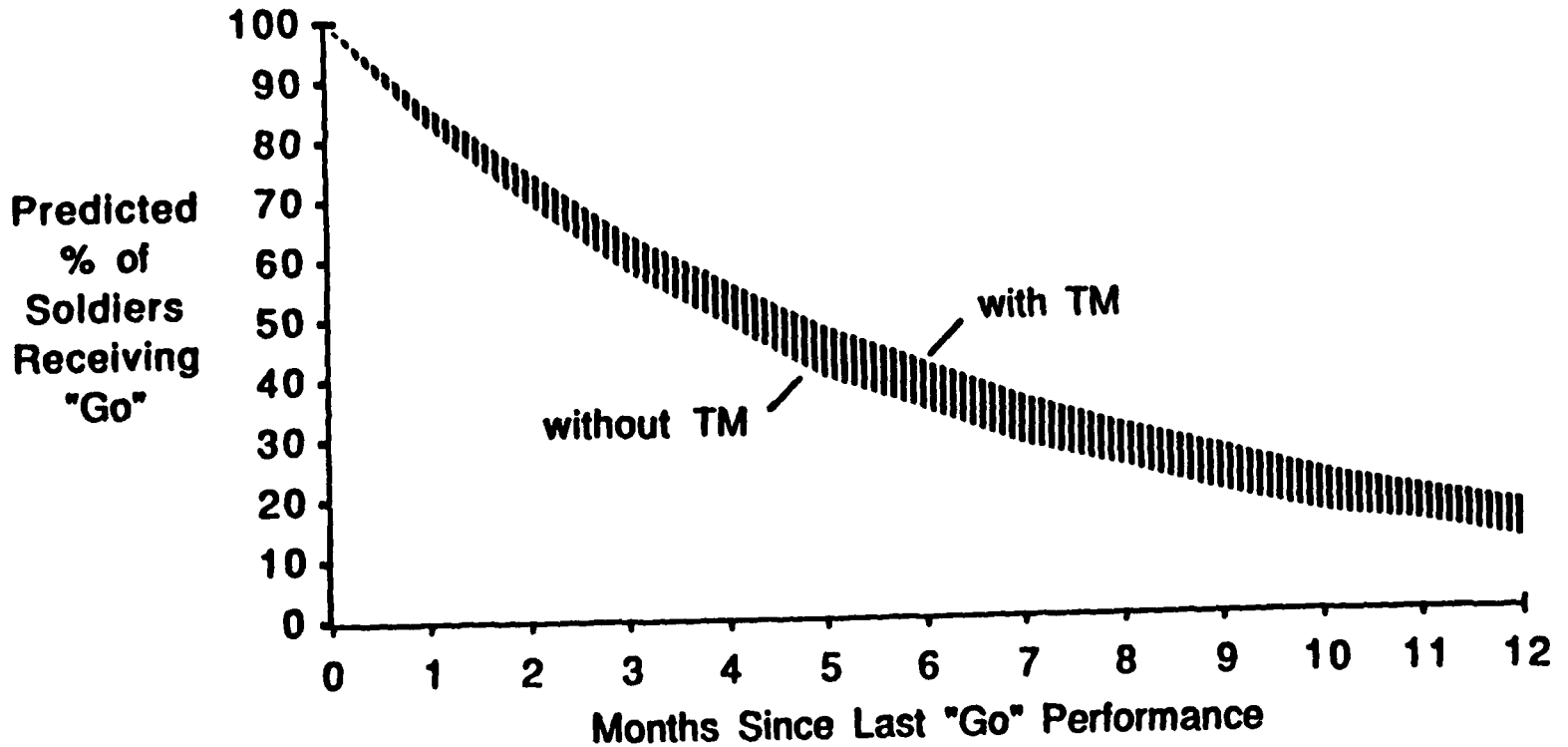
Operate the Environmental Control Unit (ECU)



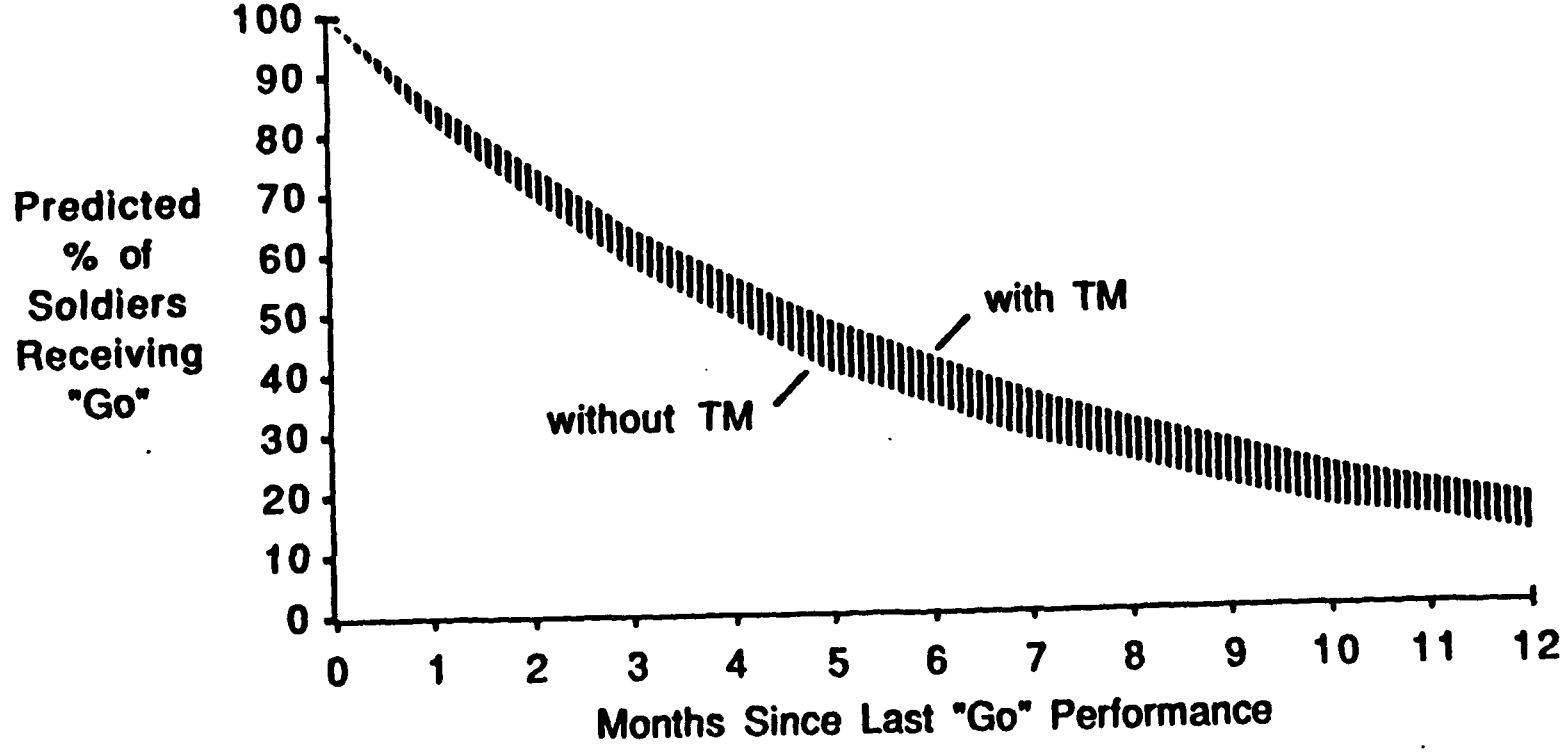
Operate the Orderwire Control Unit (OCU) C-11878/T



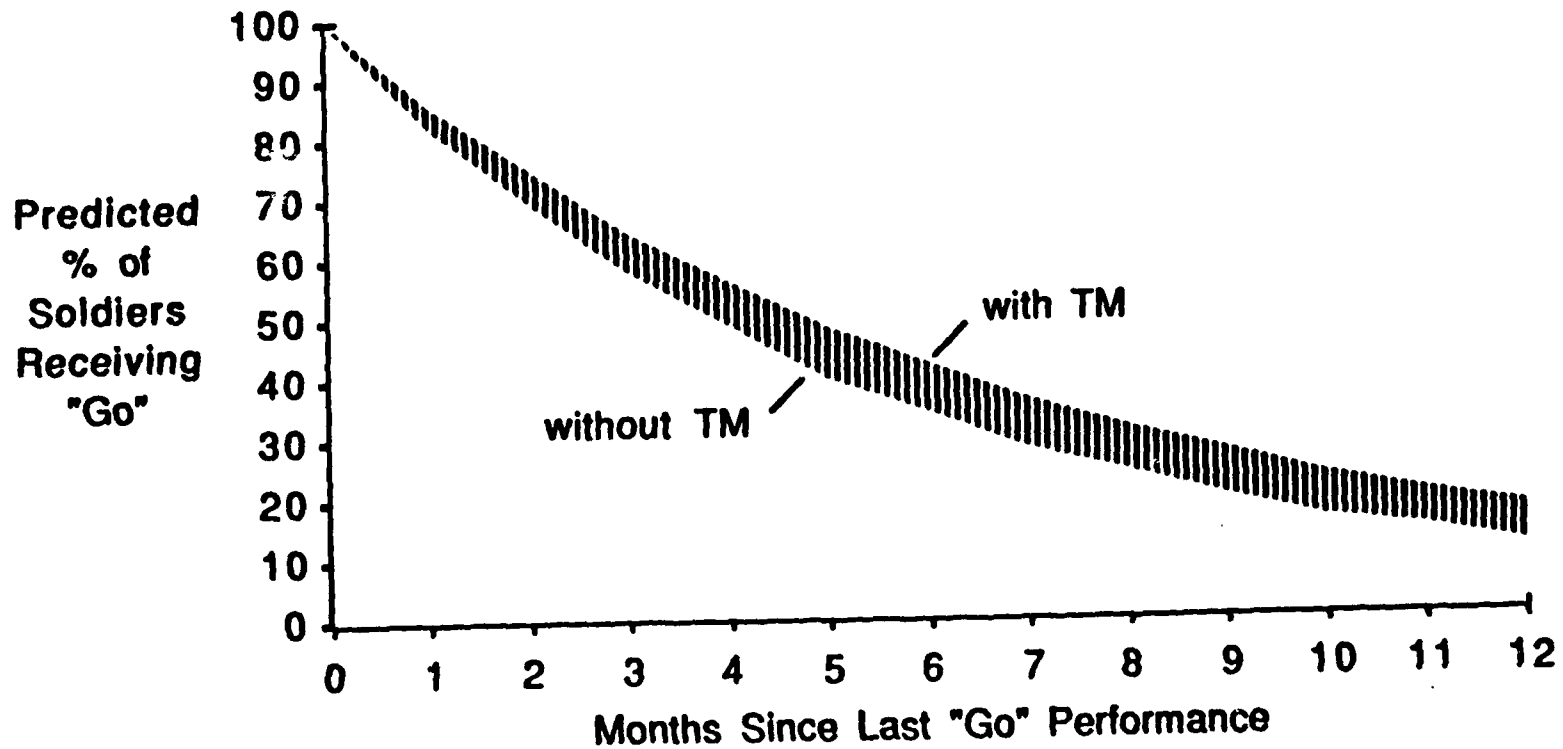
Operate Call Service Position



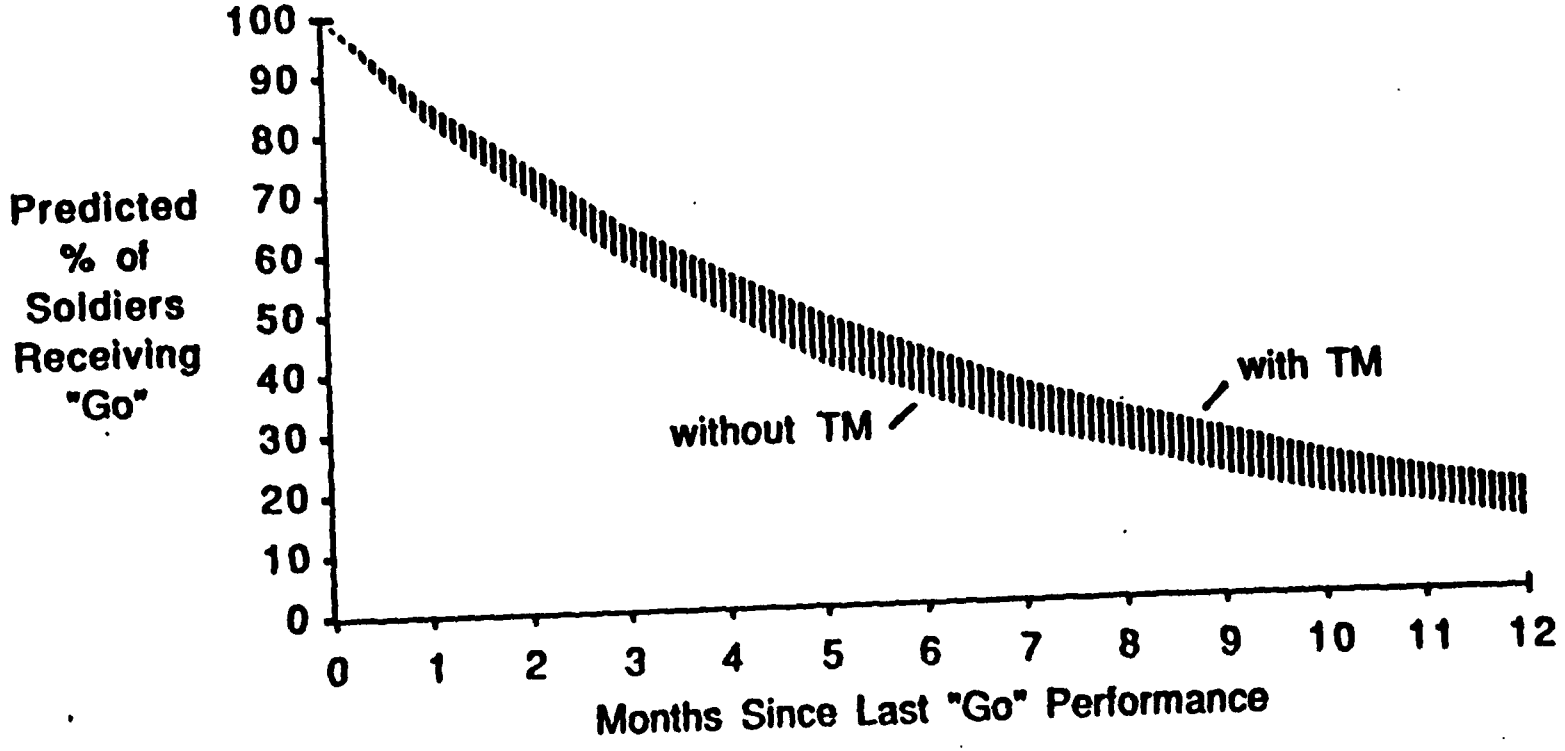
Place a Call on the OCU



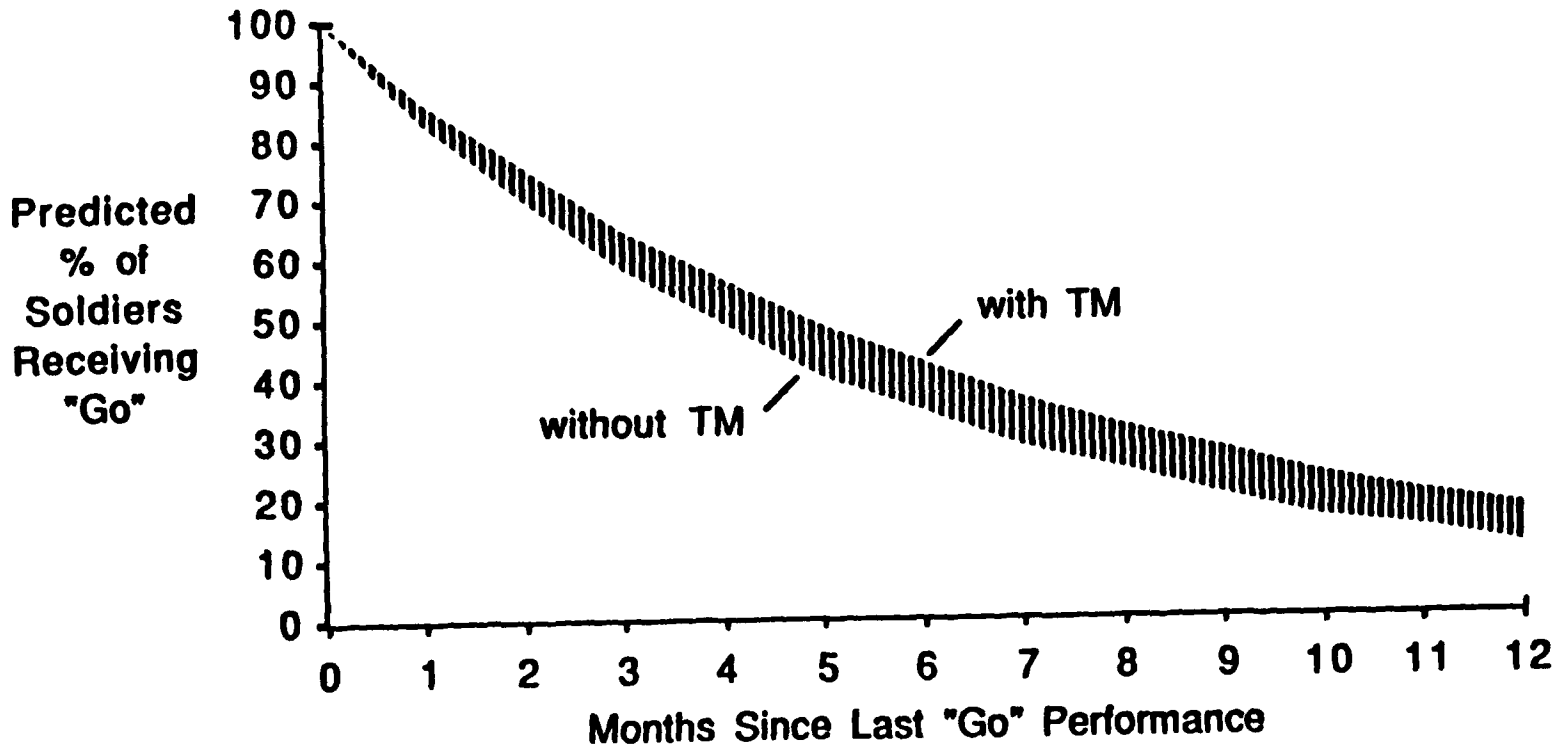
Install a Combat Net Radio (CNR) Interface in a SEN



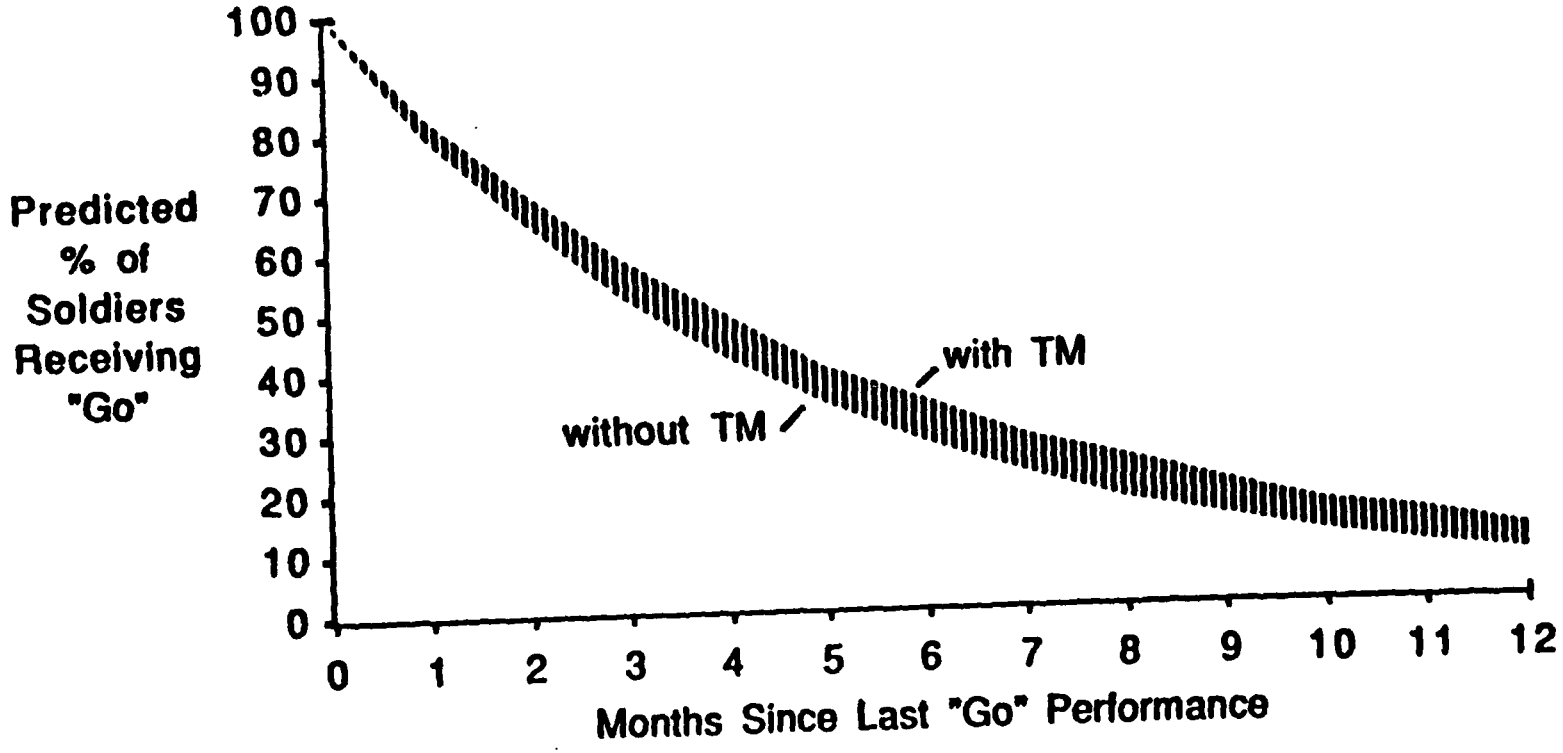
Establish Combat Net Radio (CNR) Interface



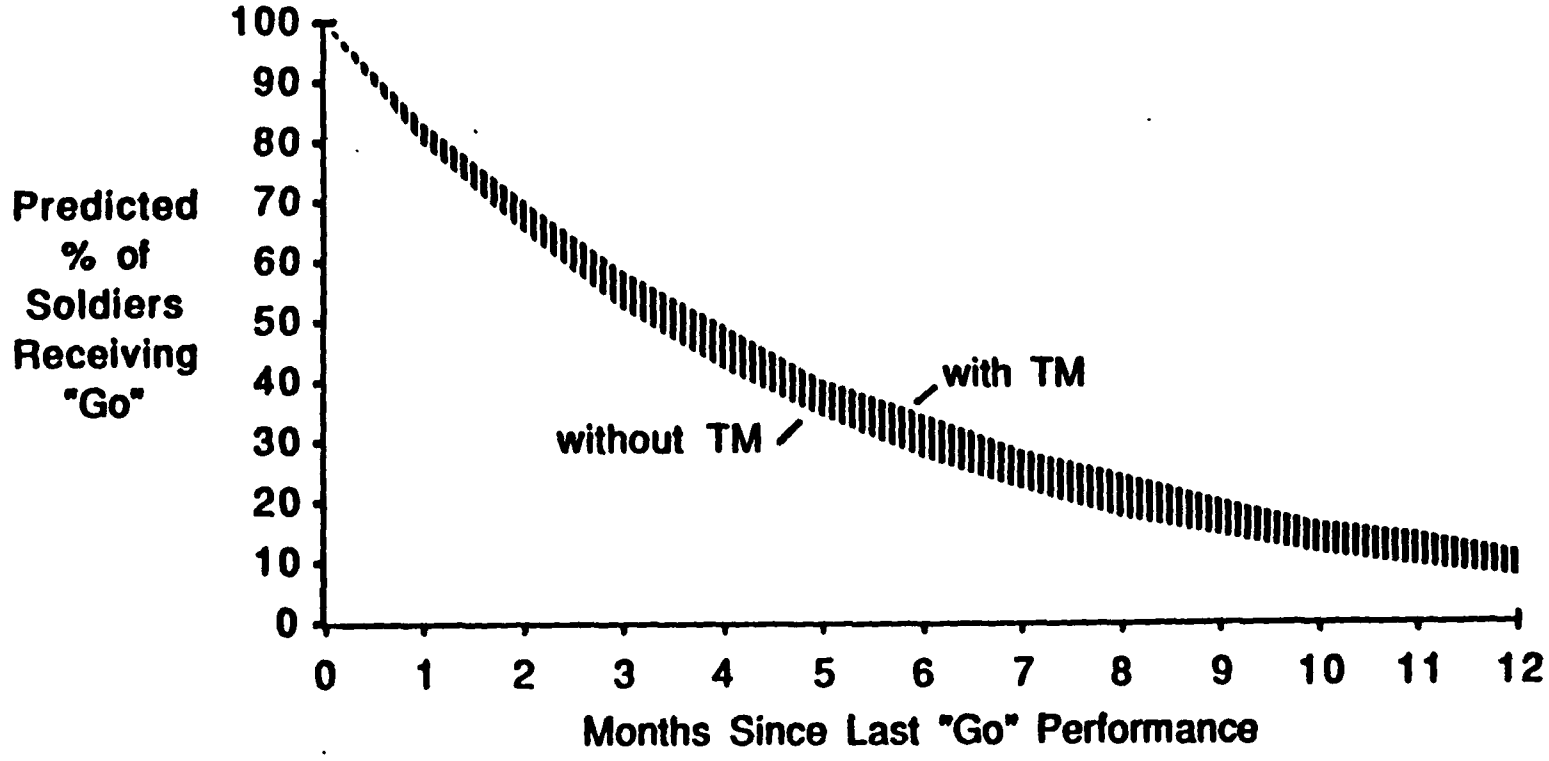
Install Remote Multiplexer Combiner (RMC)



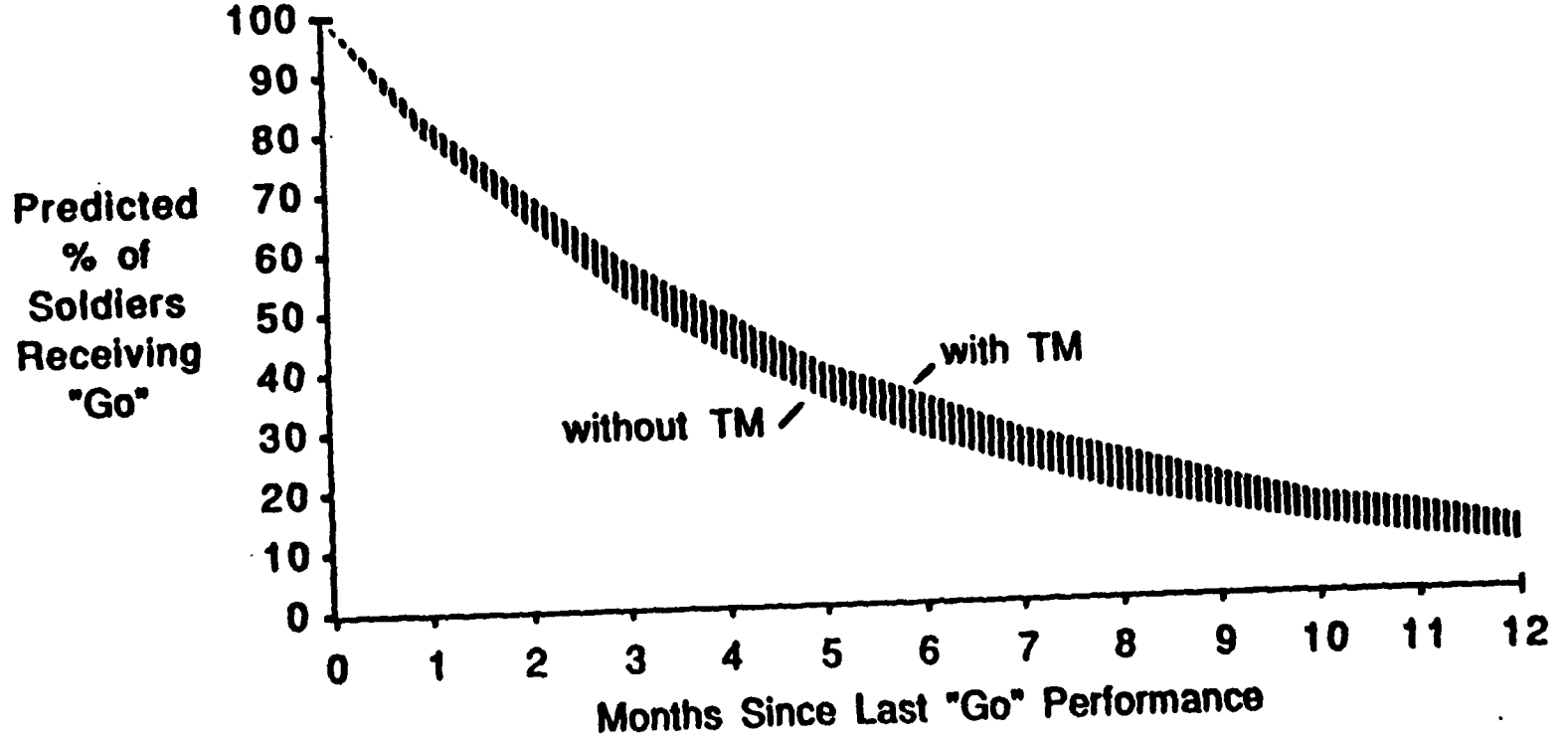
Complete an OCU Bridge Connection



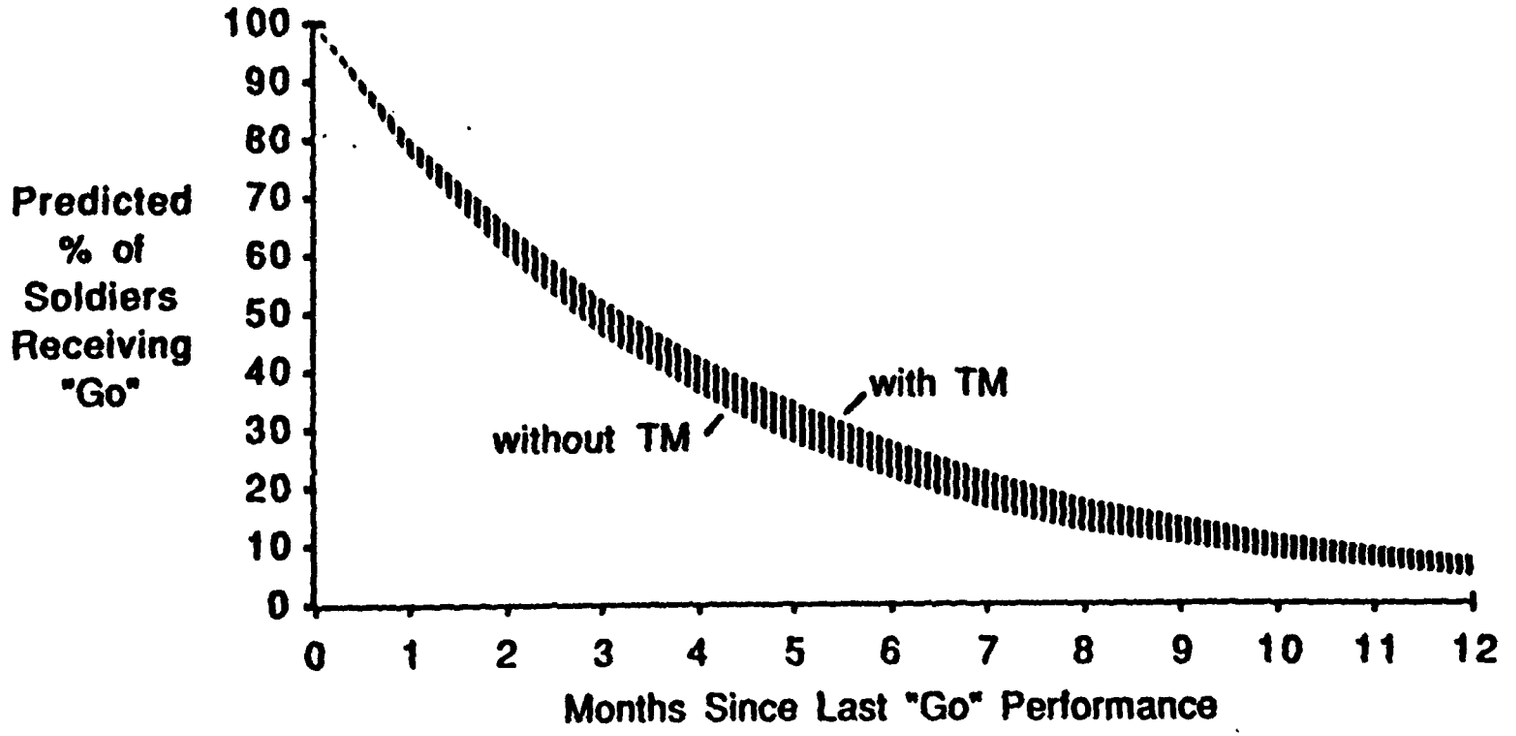
Operate Teletype Terminal AN/UGC-74B



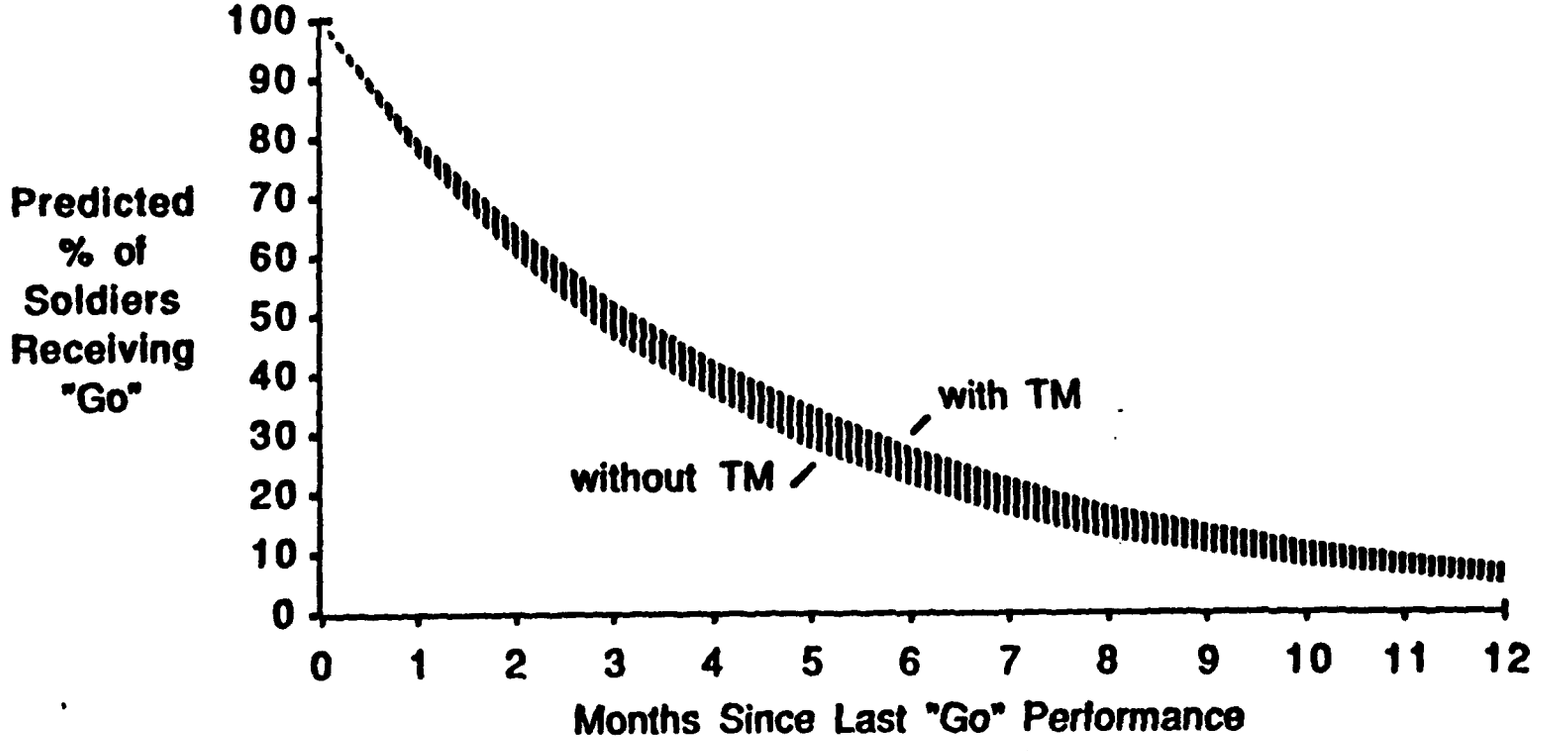
Perform Remote Multiplexer Combiner (RMC) Turn On



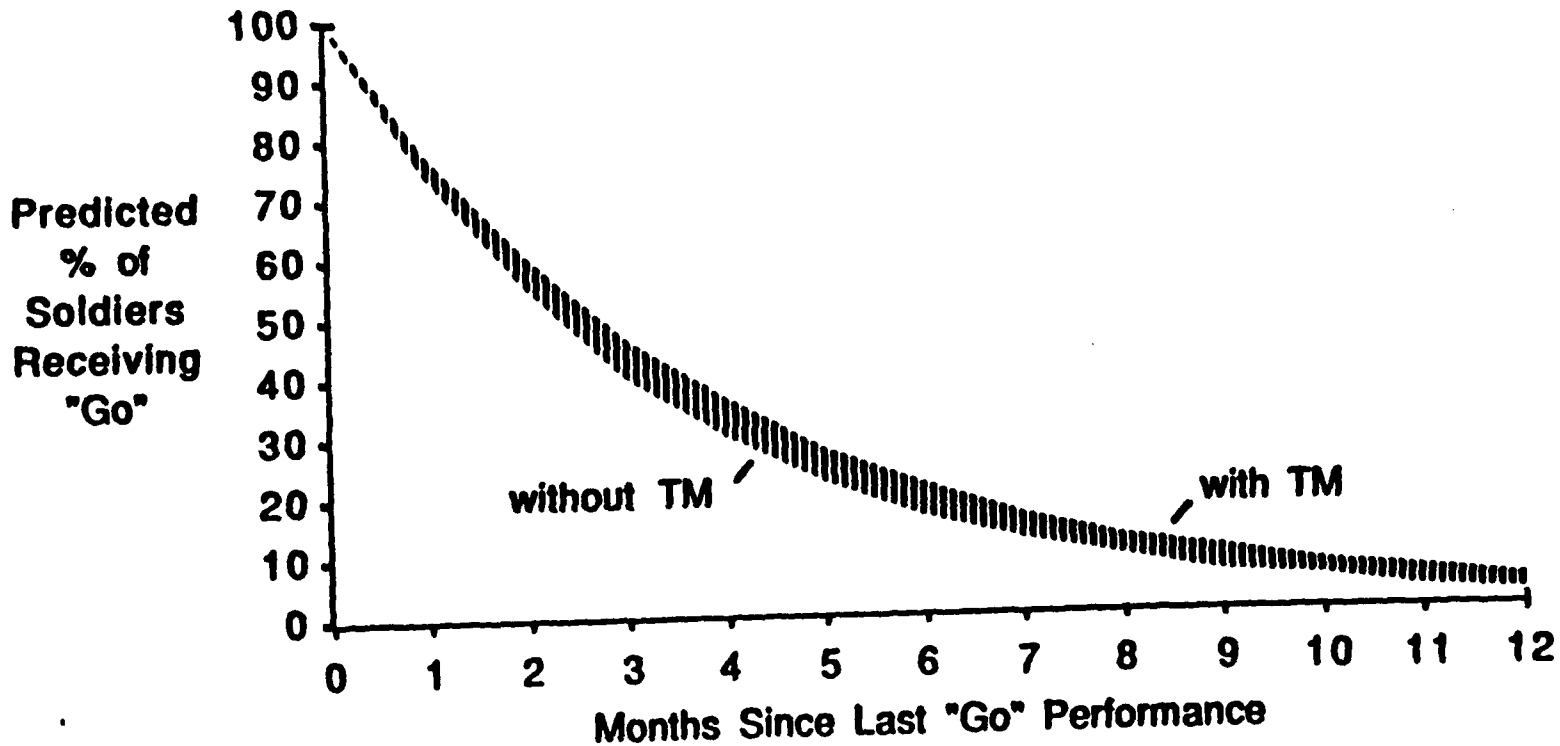
Operate COMSEC Equipment TSEC/KY-57



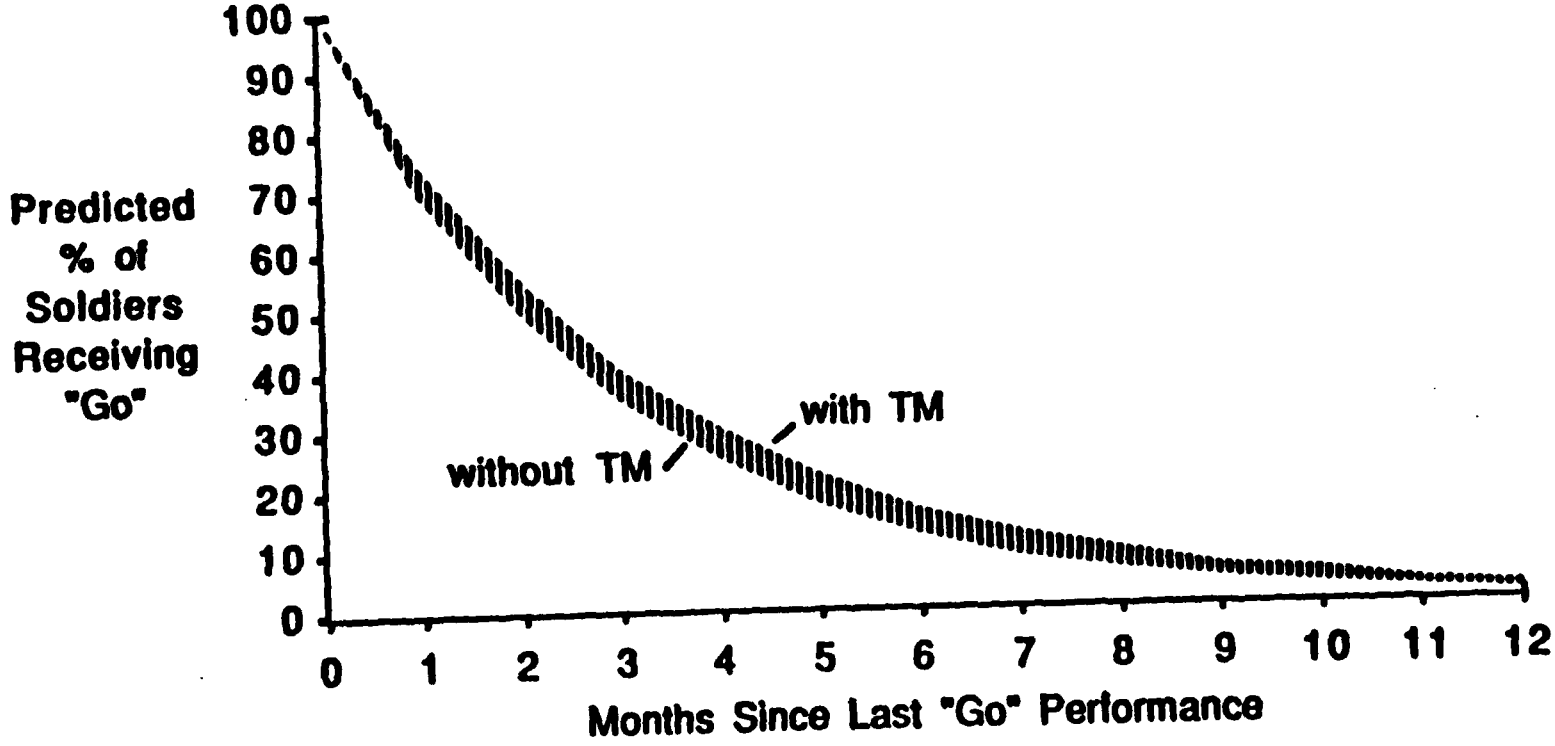
Manually Load Frequency Plan



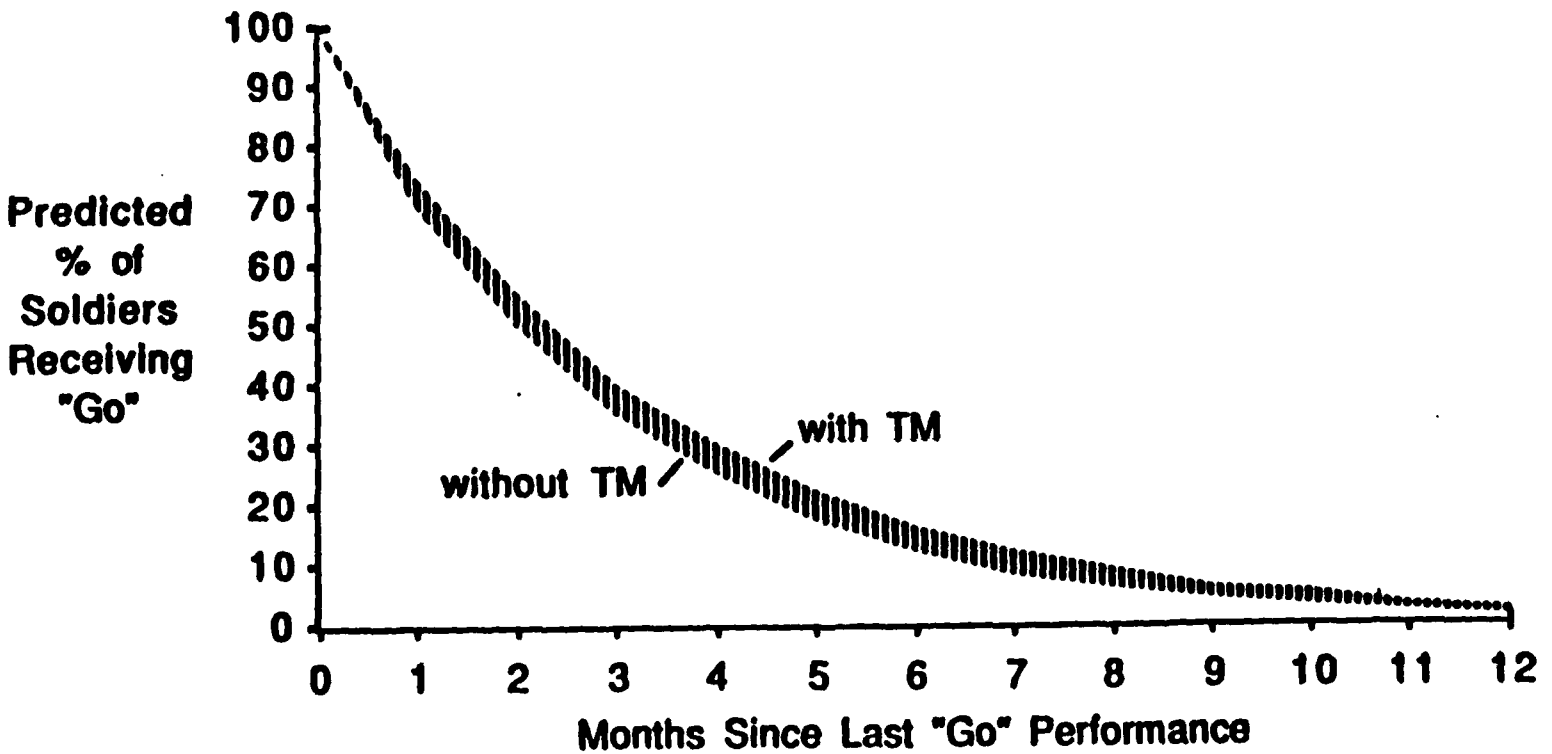
Perform AC Power Initialization on LEN



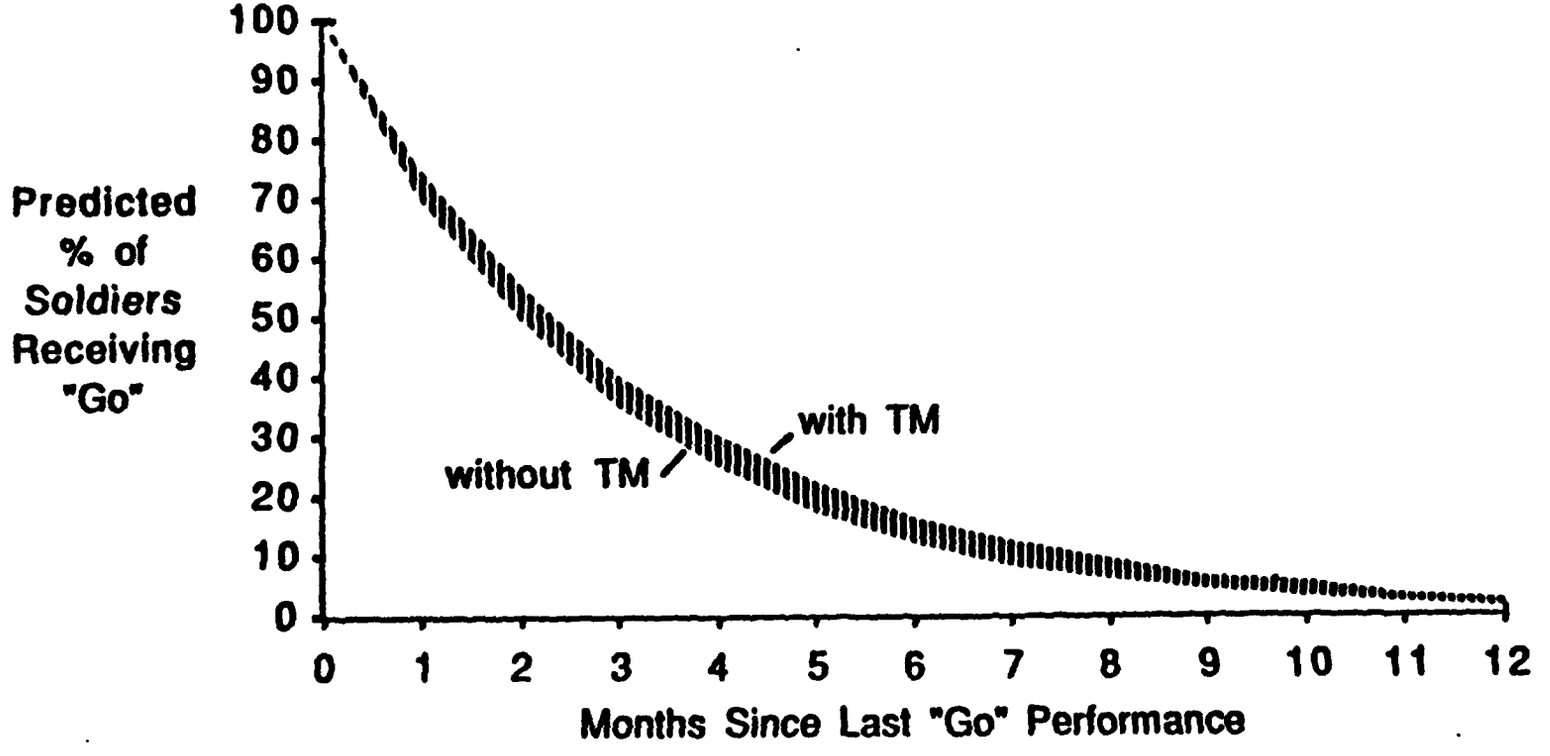
Operate Key Loader KYX-15



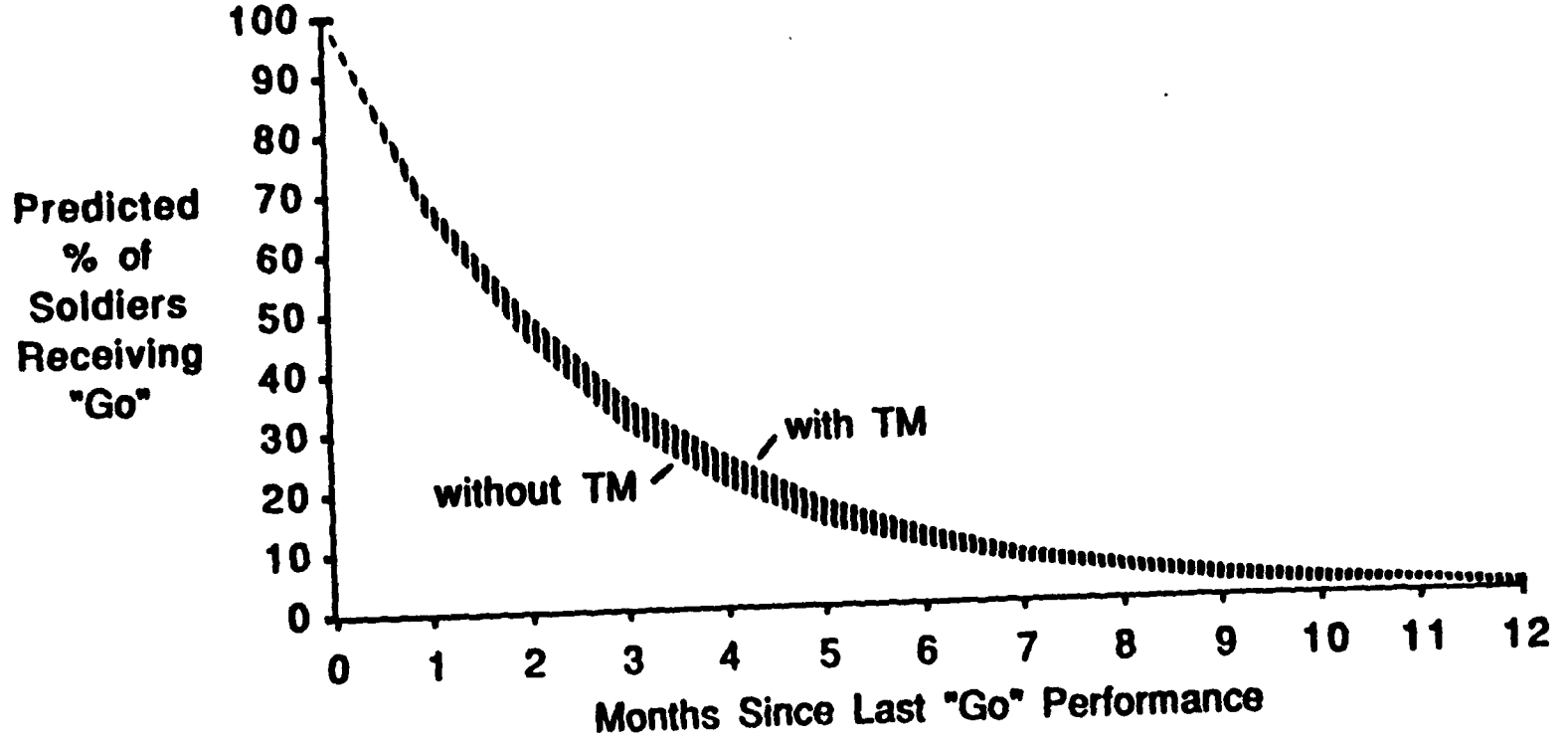
Initialize the AN/GRC-224 (SHF Radio)



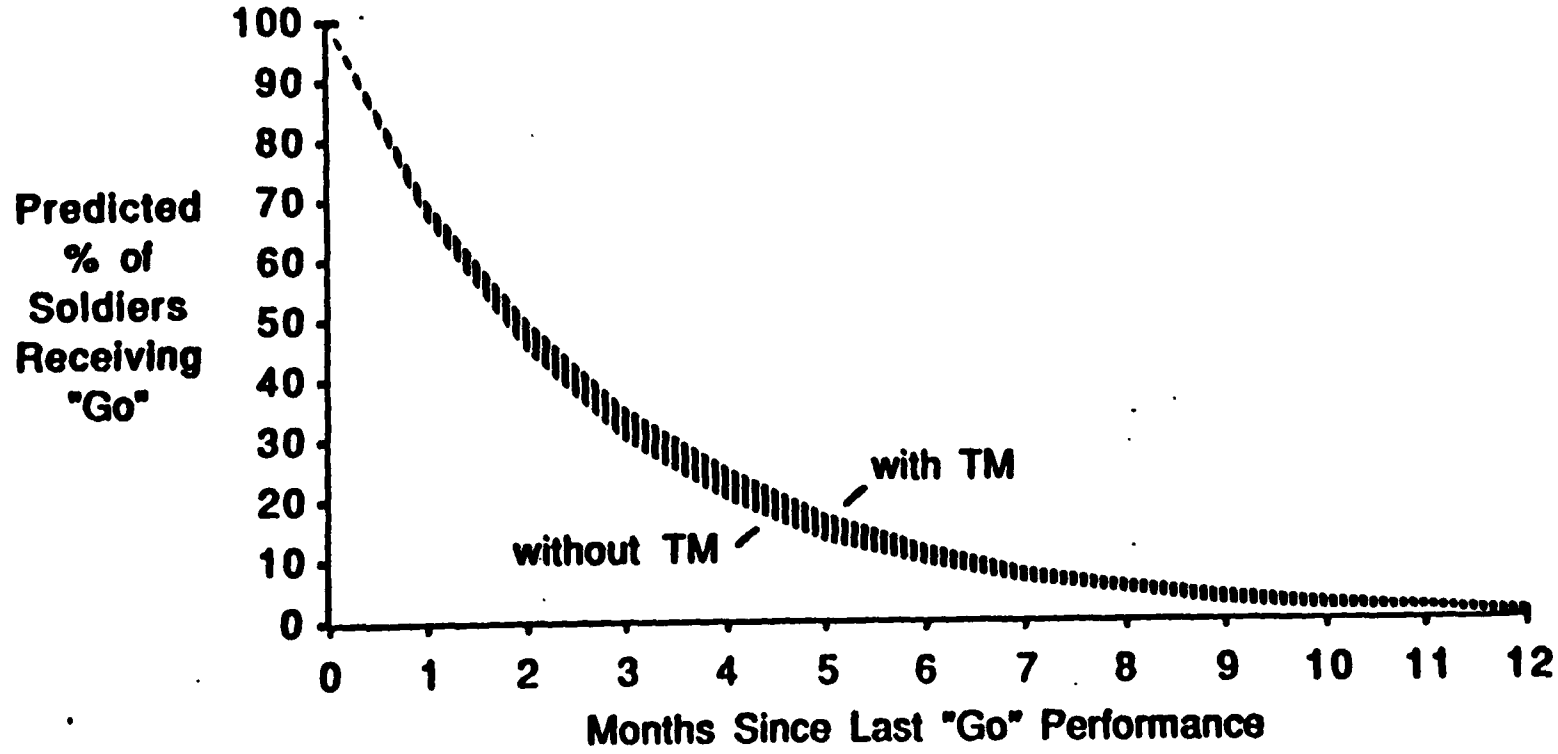
Perform an Essential User Bypass (EUB) as the Bypass Switch



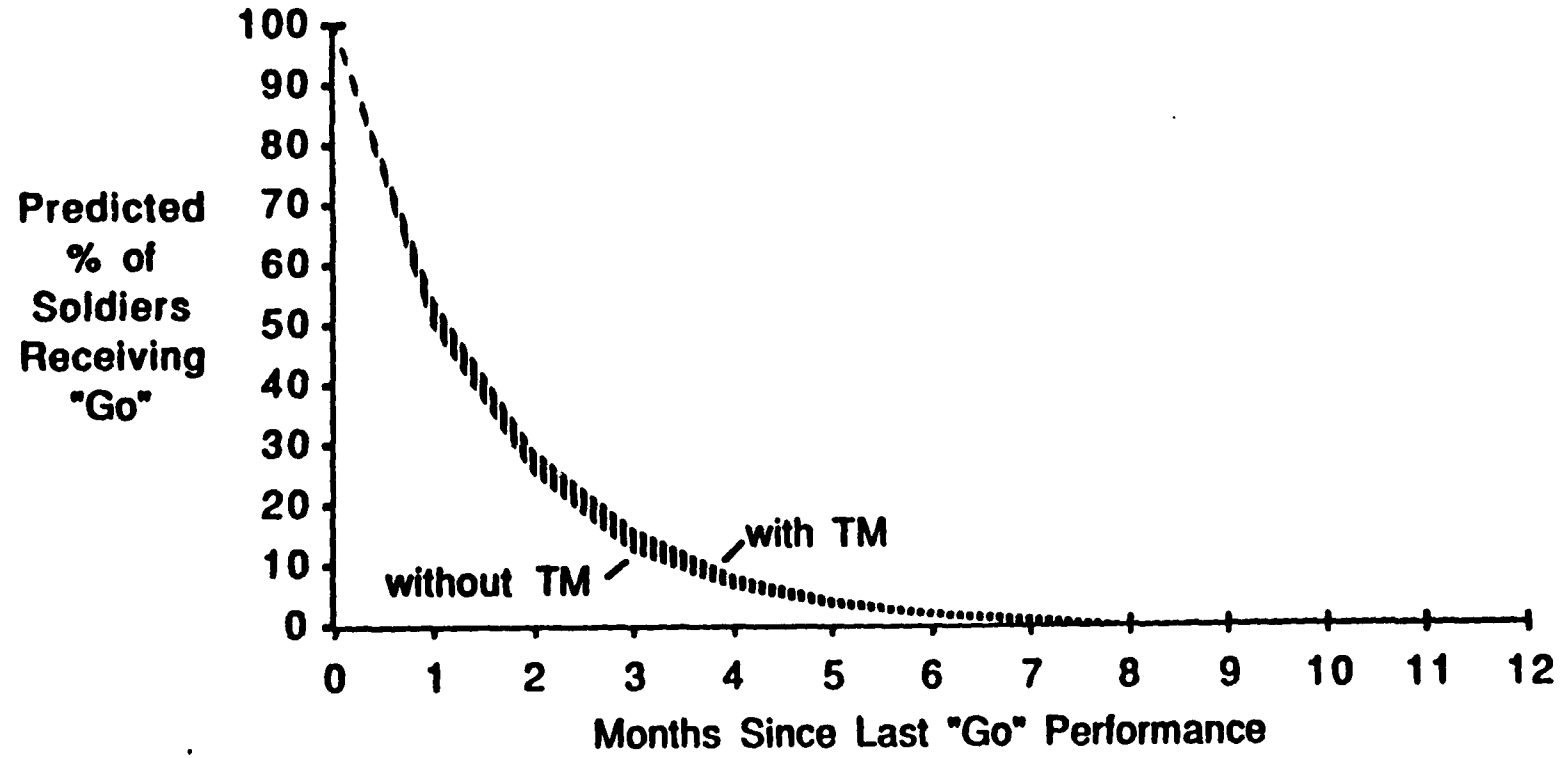
Perform an Essential User Bypass (EUB) as the Receiving Switch



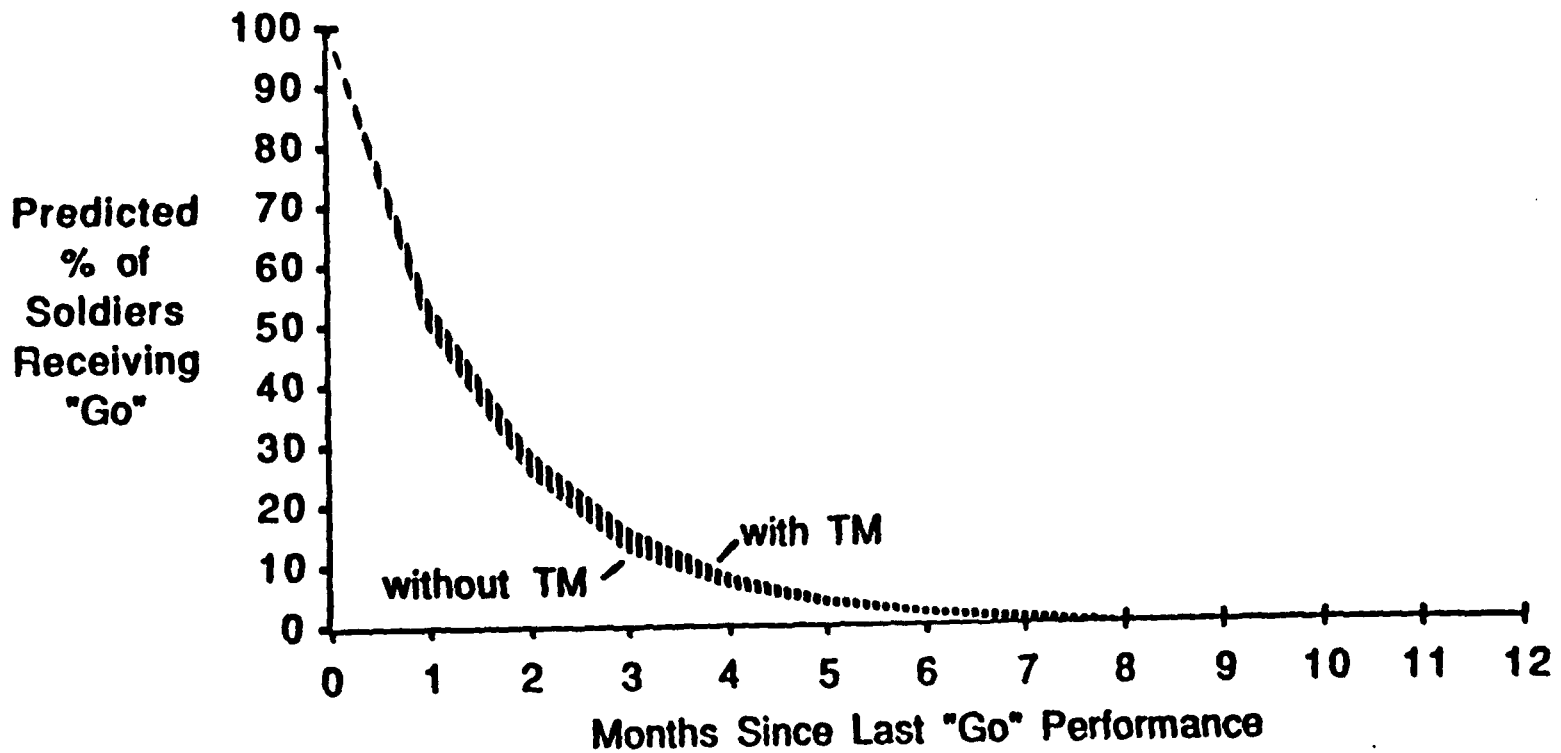
Establish Super High Frequency (SHF) Link



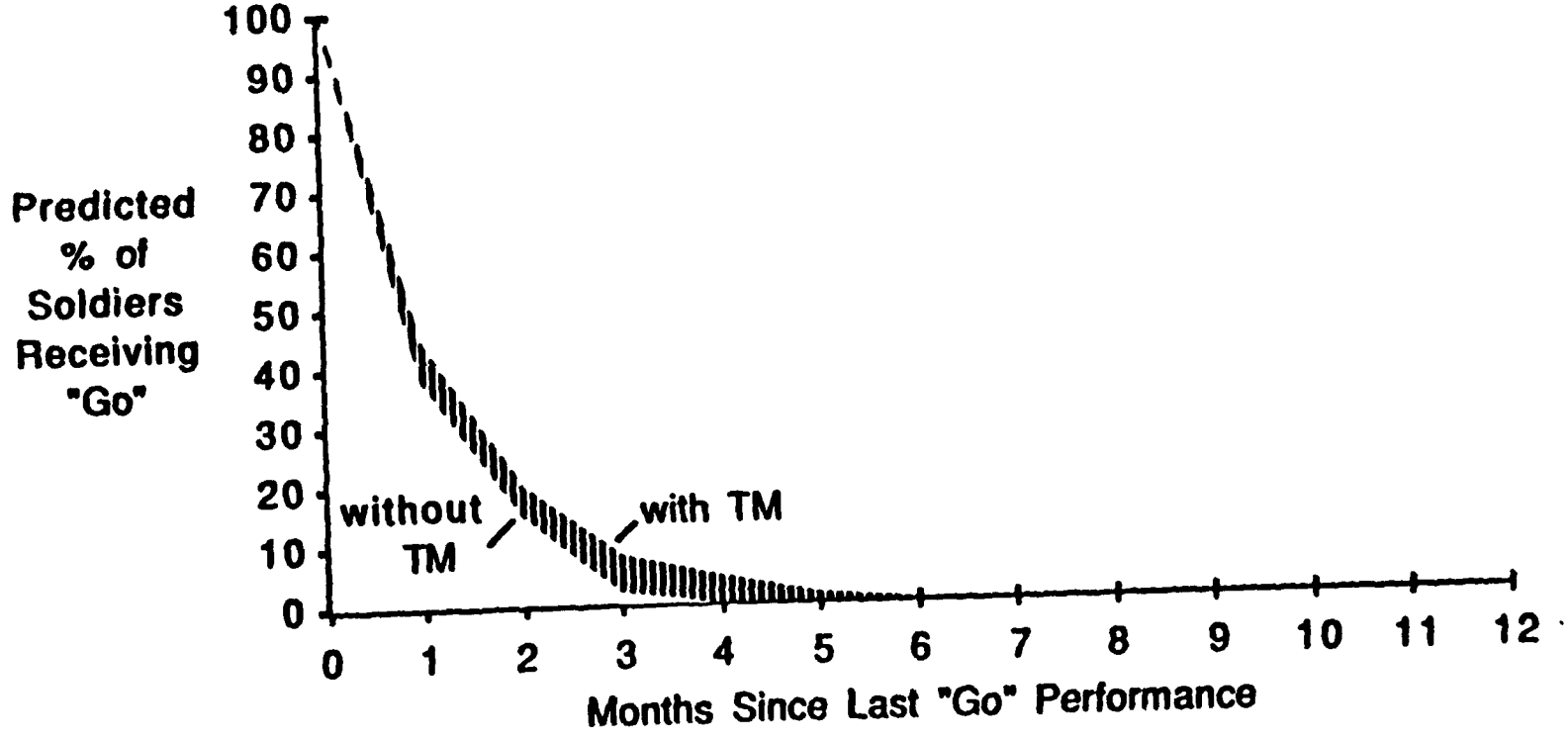
Install Net Radio Interface (NRI) KY-90



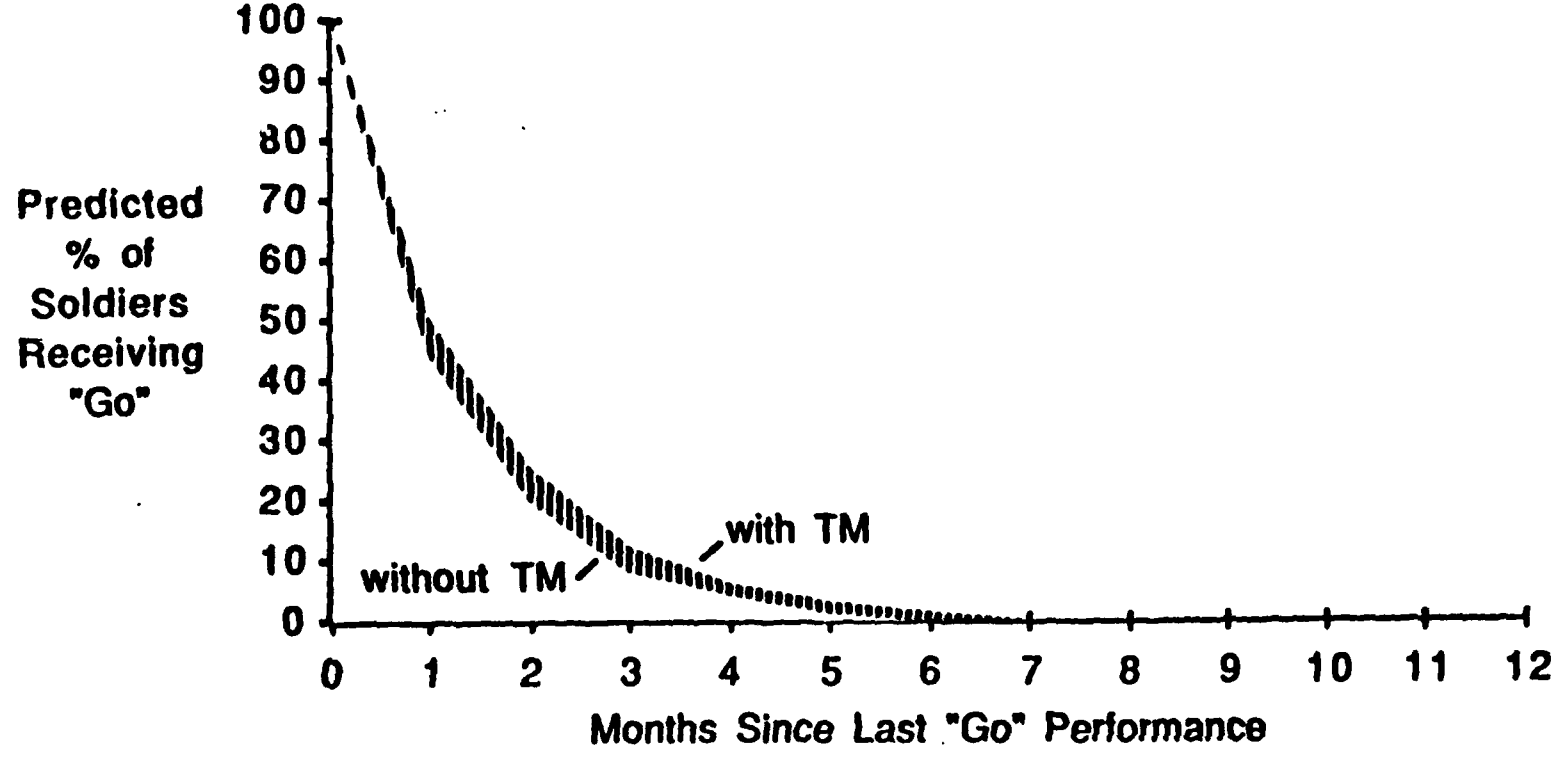
Operate Net Radio Interface (NRI) KY-90



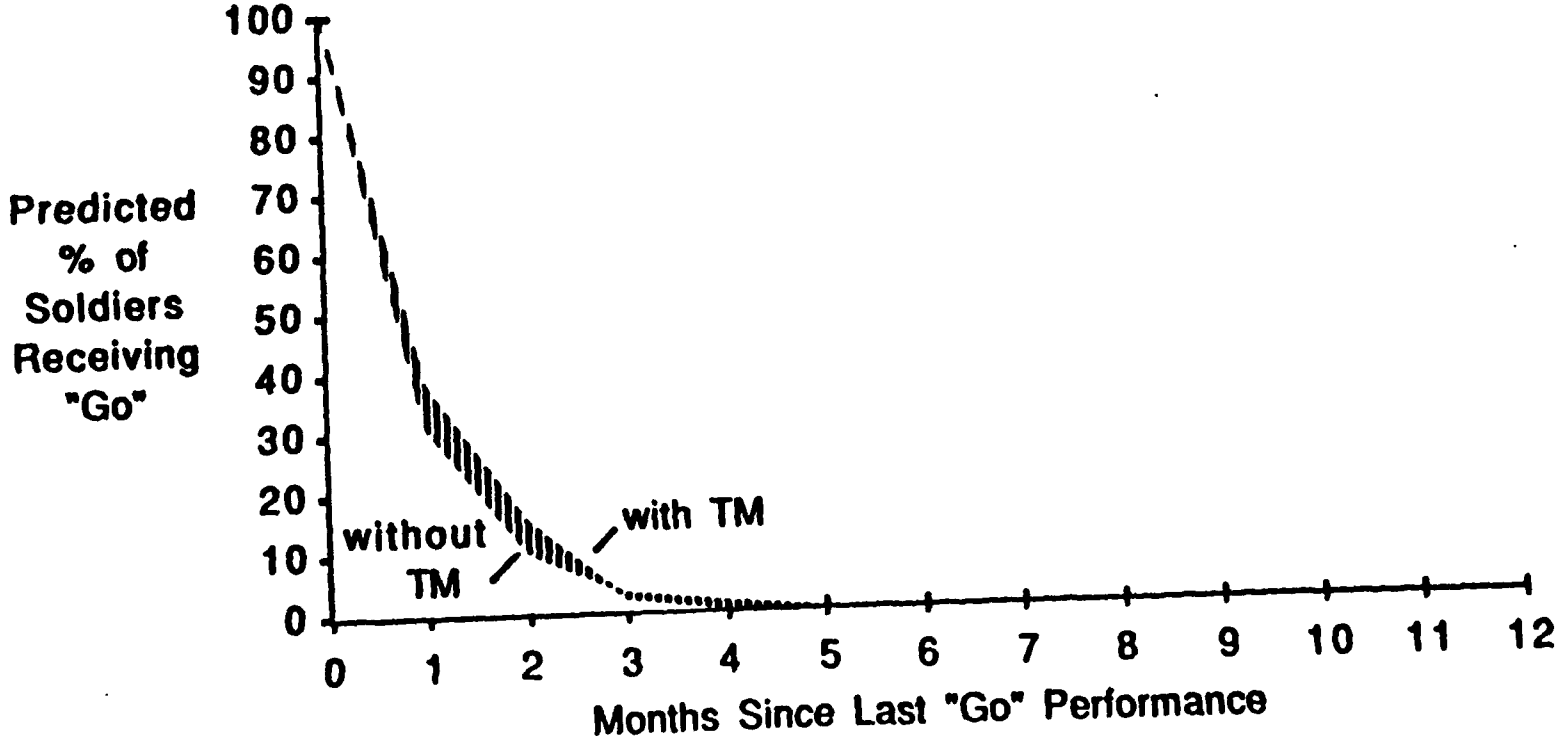
Generate and Control MSE COMSEC Keys



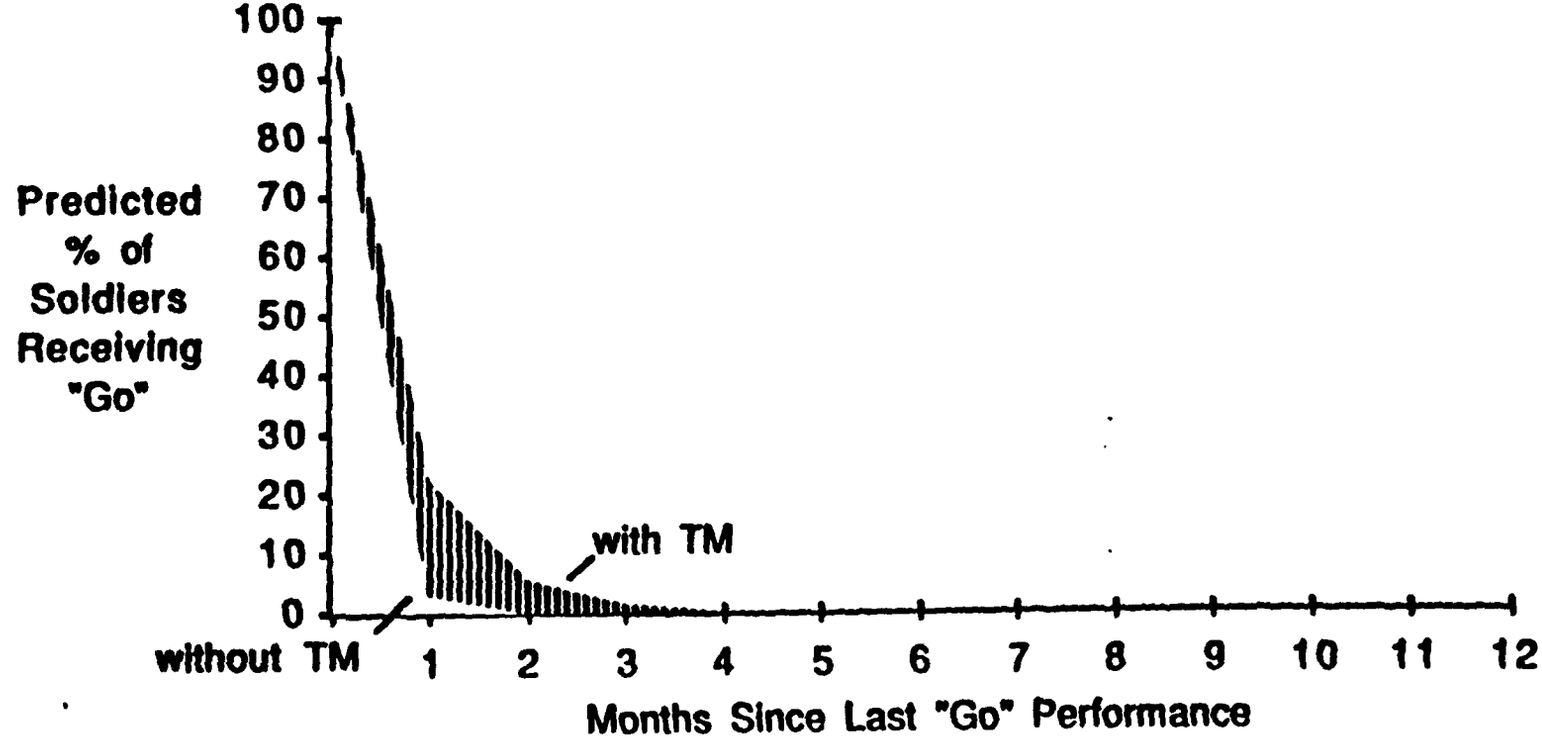
Perform AN/TTC-47 (NCS) Data Base Modifications



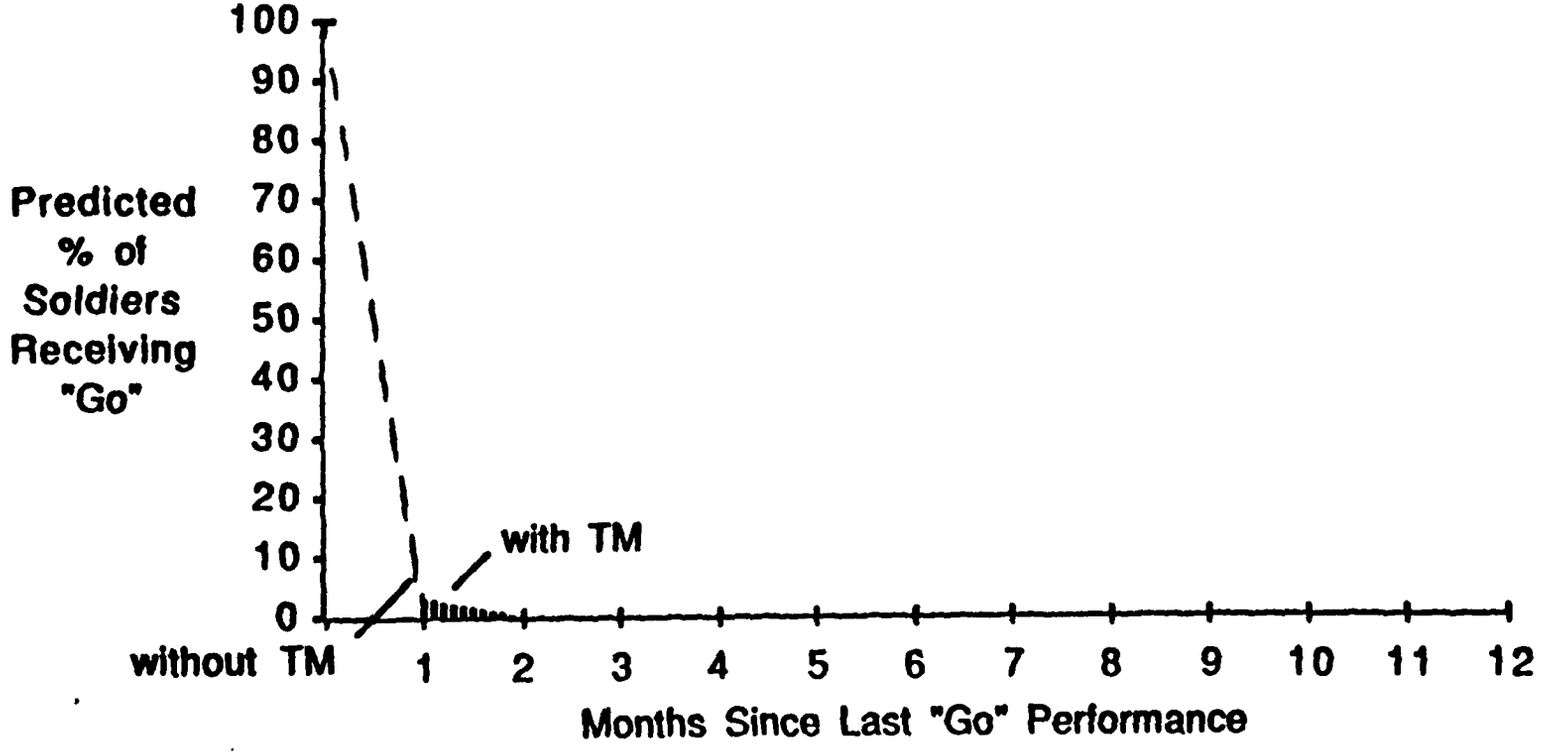
Perform AN/TTC-46 (LENS) Data Base Modifications



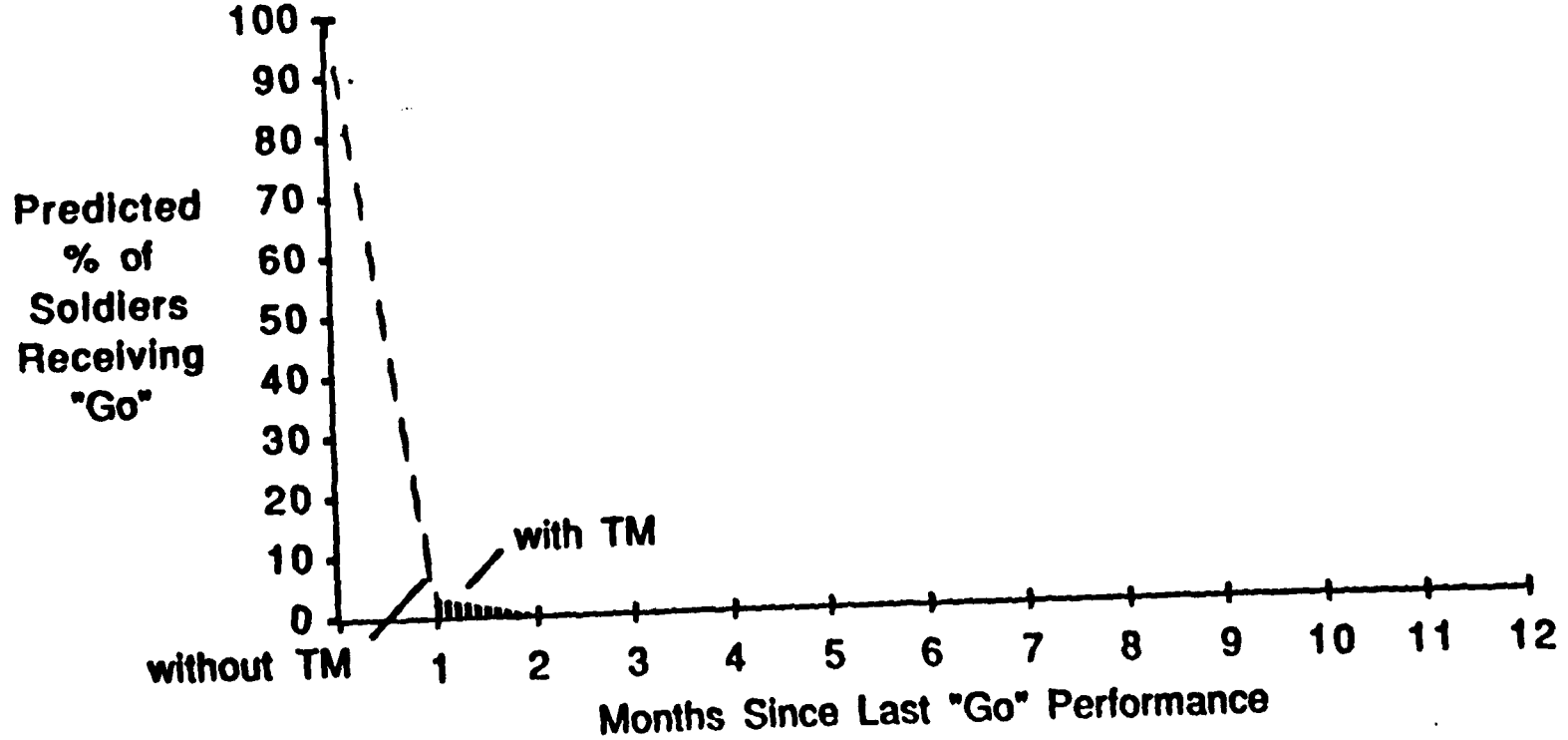
Initialize Node Center Switch (NCS)



Initialize Large Extension Node (LEN) Switch



Recover Node Center (NC) from Essential User Bypass (EUB)



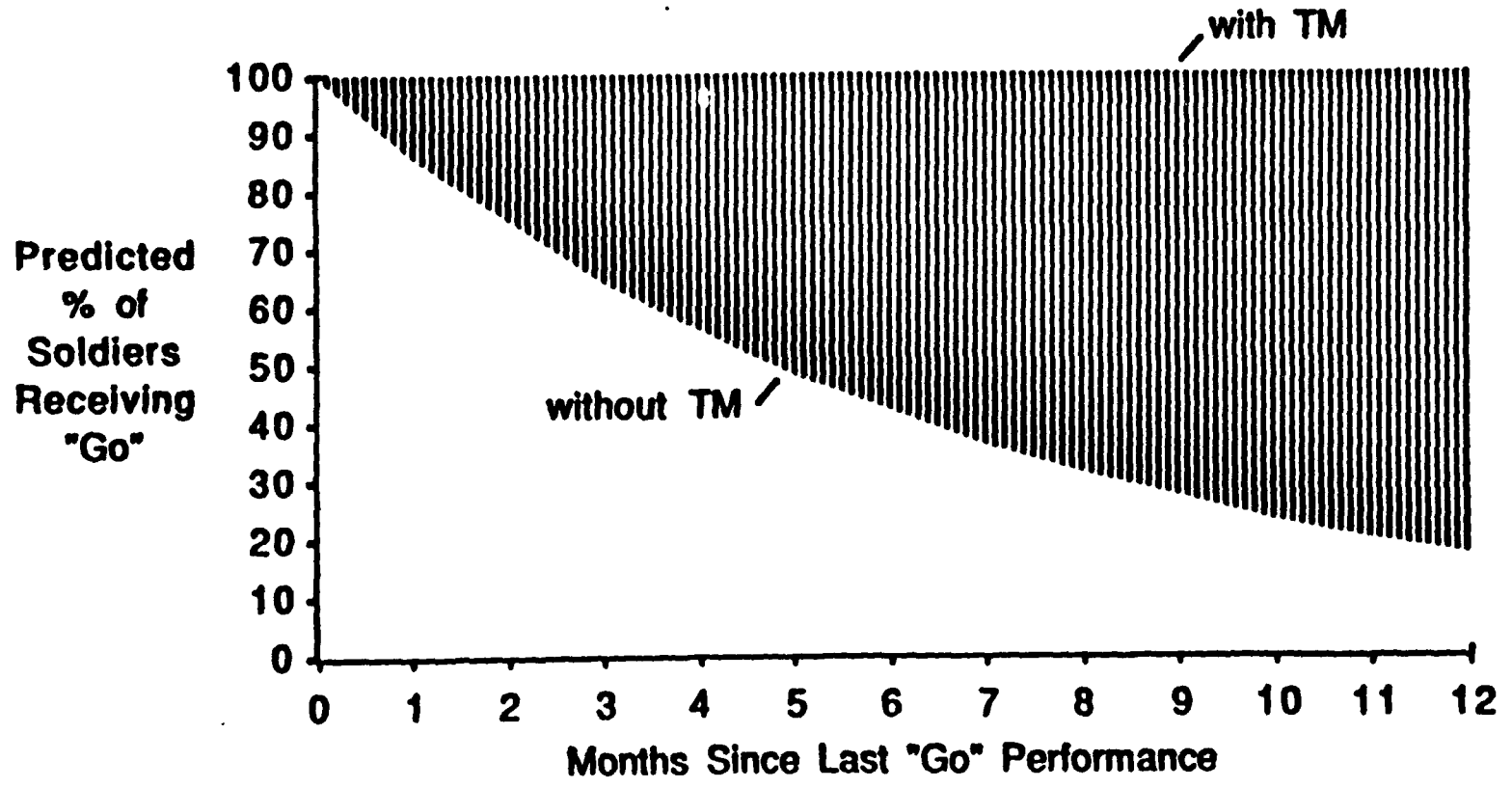
APPENDIX C

MOS 31F ASI V4 Procedures

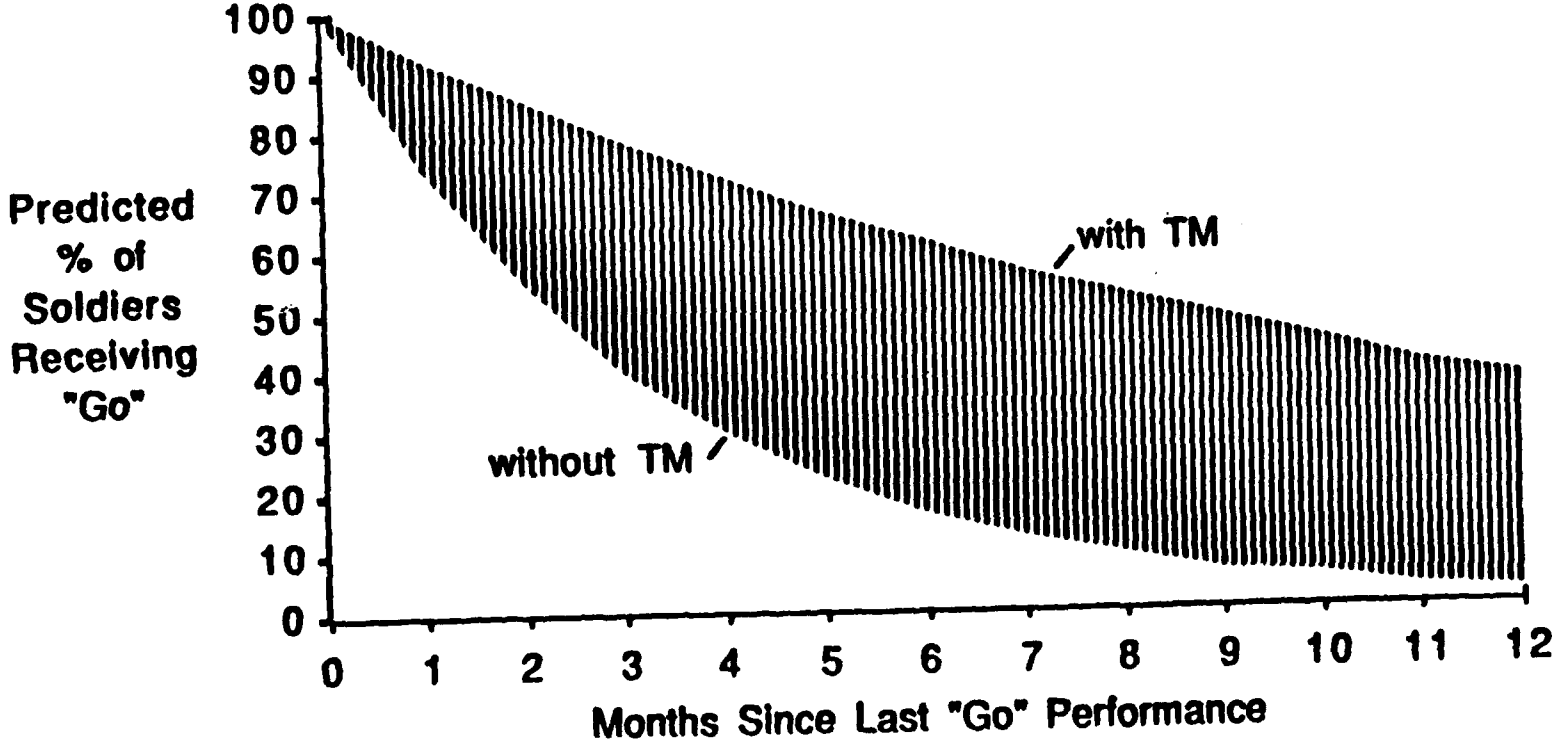
APPENDIX C

MOS 31F ASI V4 Procedures (continued)

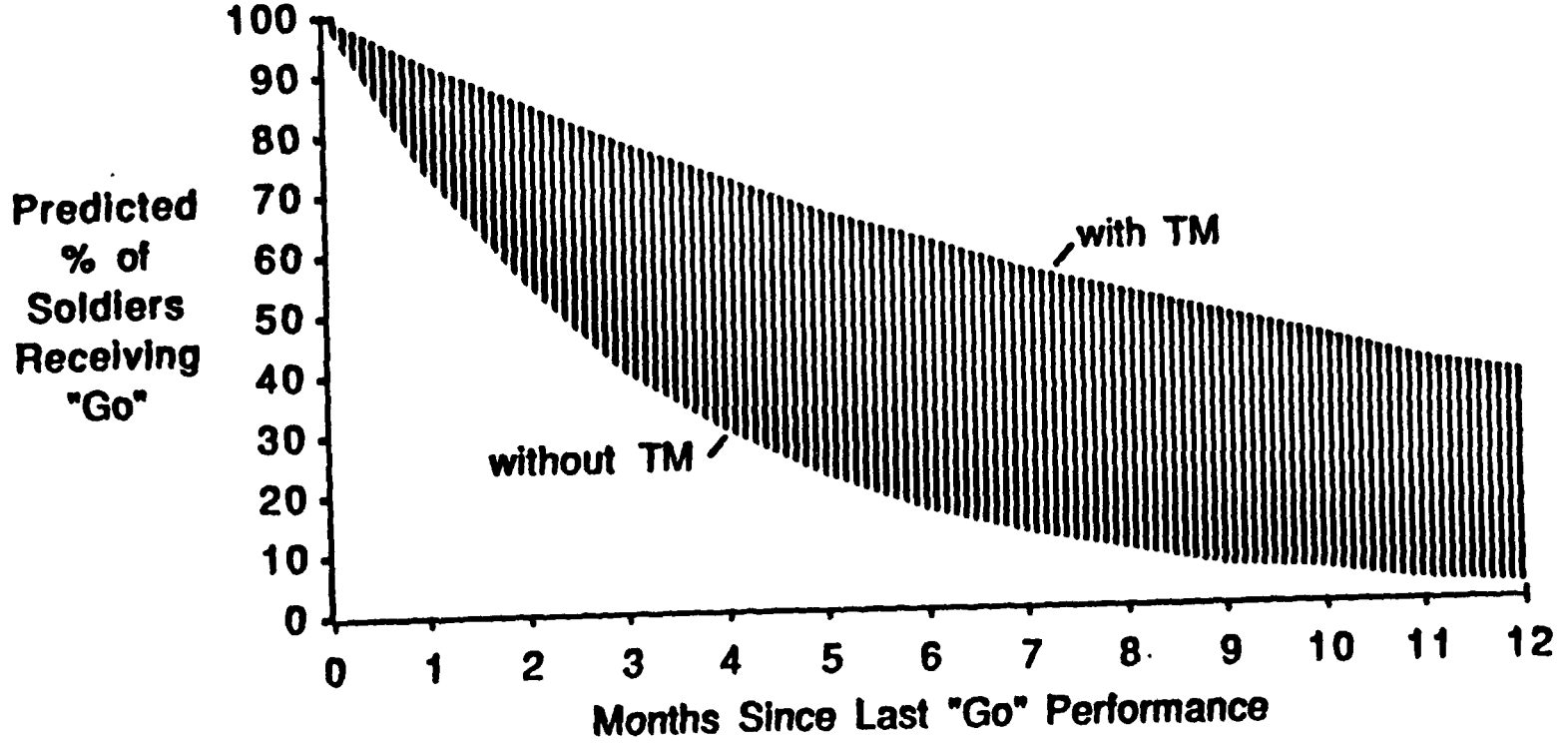
Perform an Over-the-Air Rekey (OTAR) to a Subordinate Switch and Associated LOS(s)



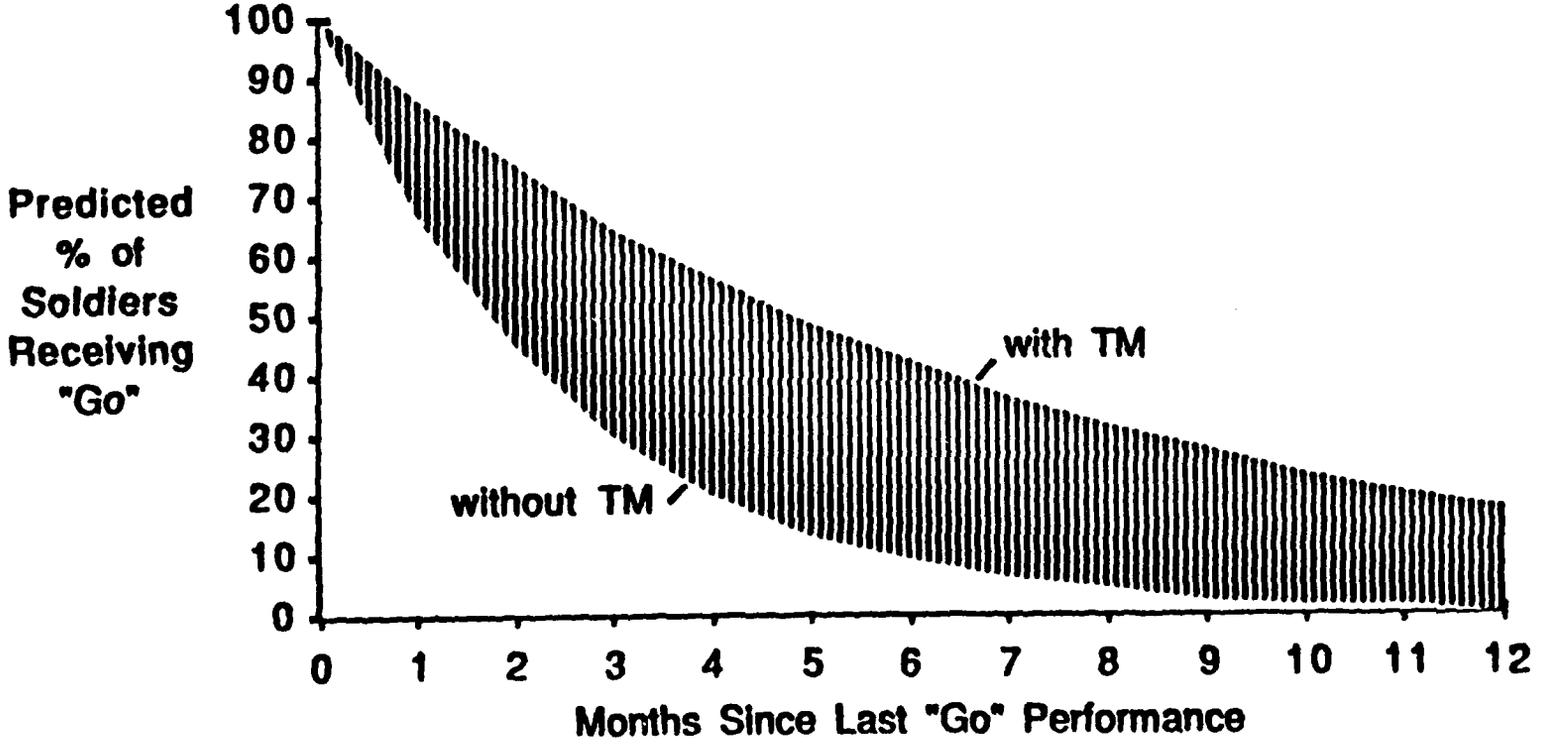
Initialize an Extension Link as the First Link of an MDTG



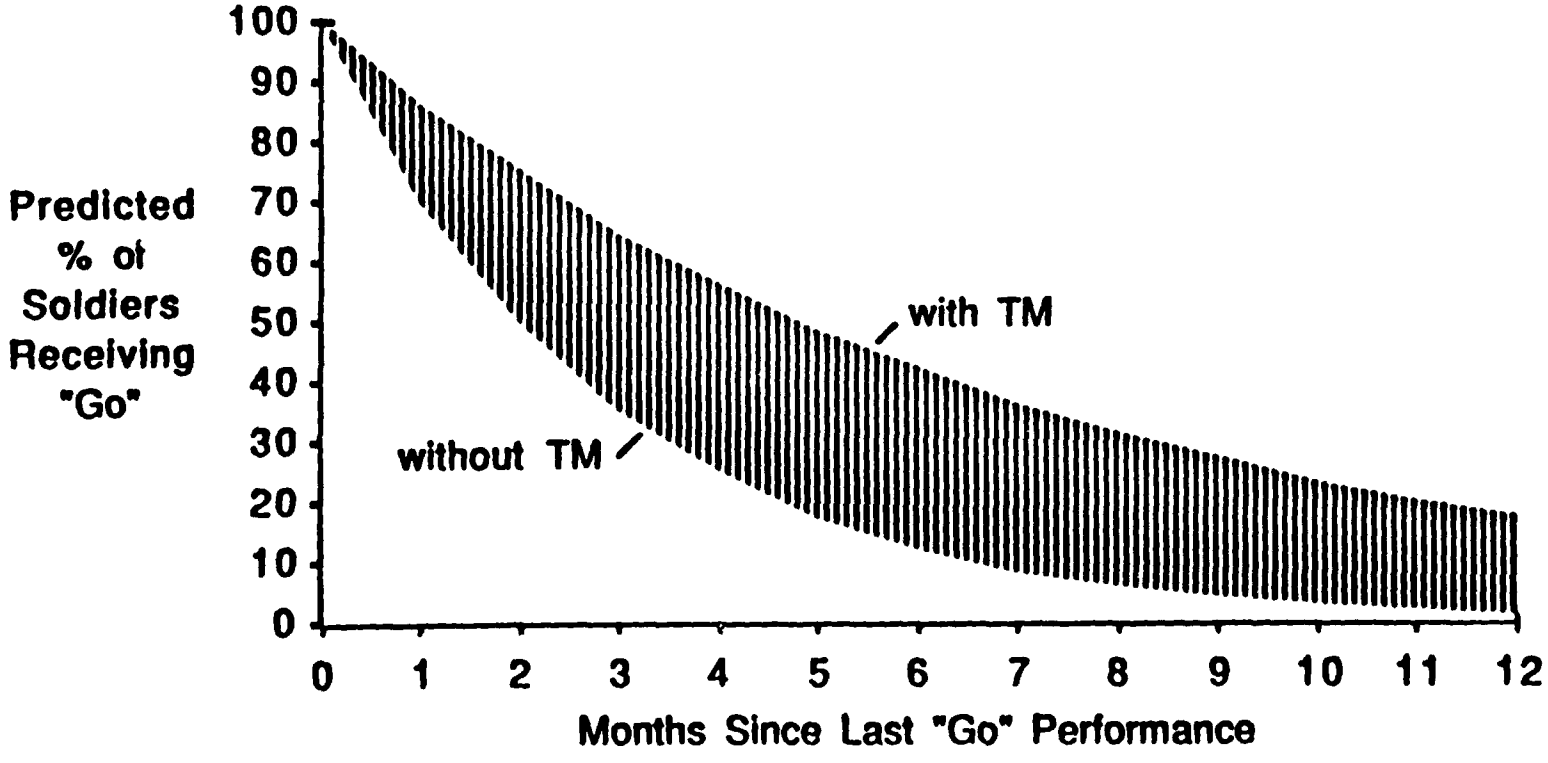
Initialize an Extension Link as the Second Link of an MDTG



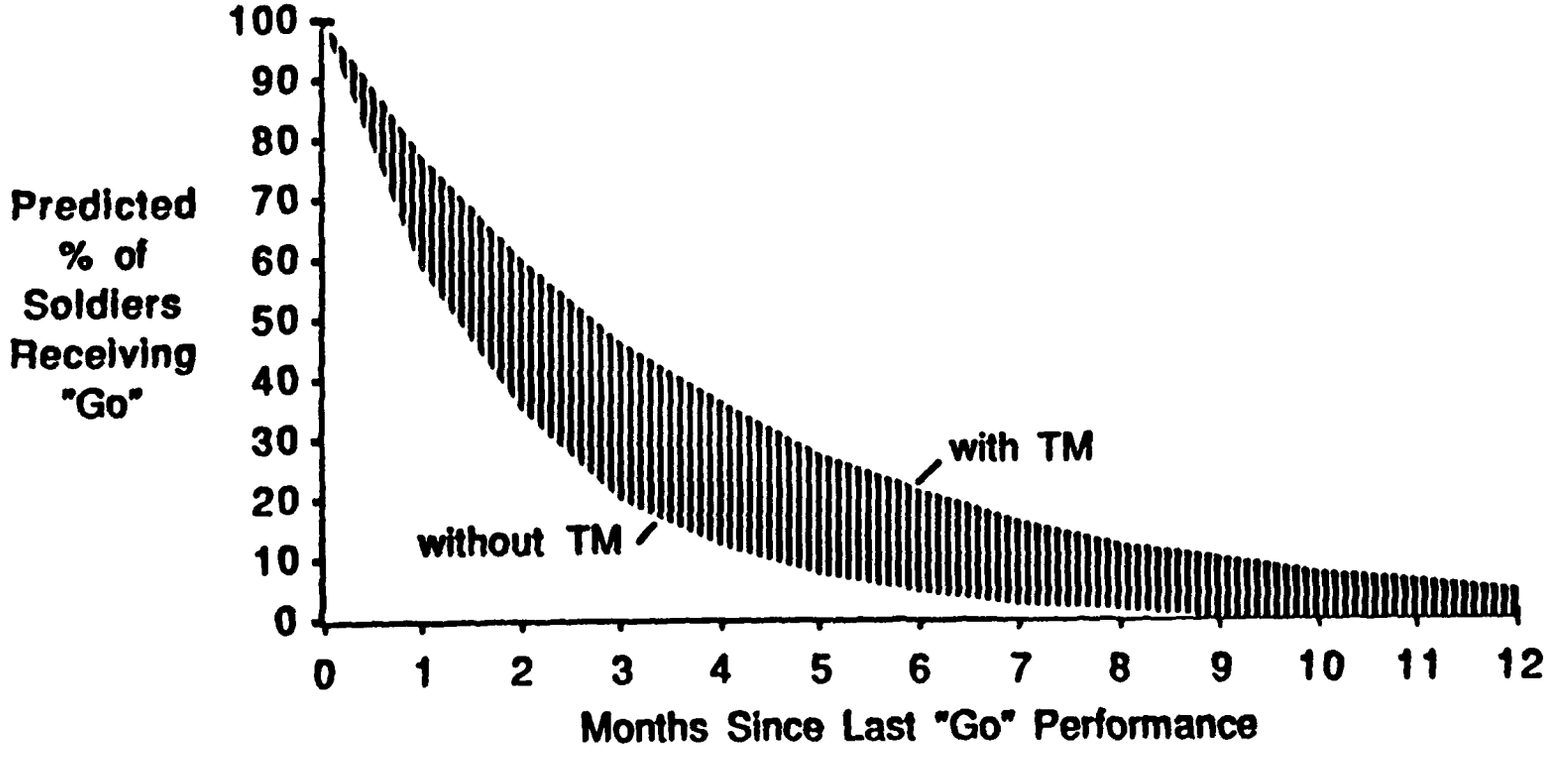
Initialize an Interswitch Link as the Second Link of an MDTG



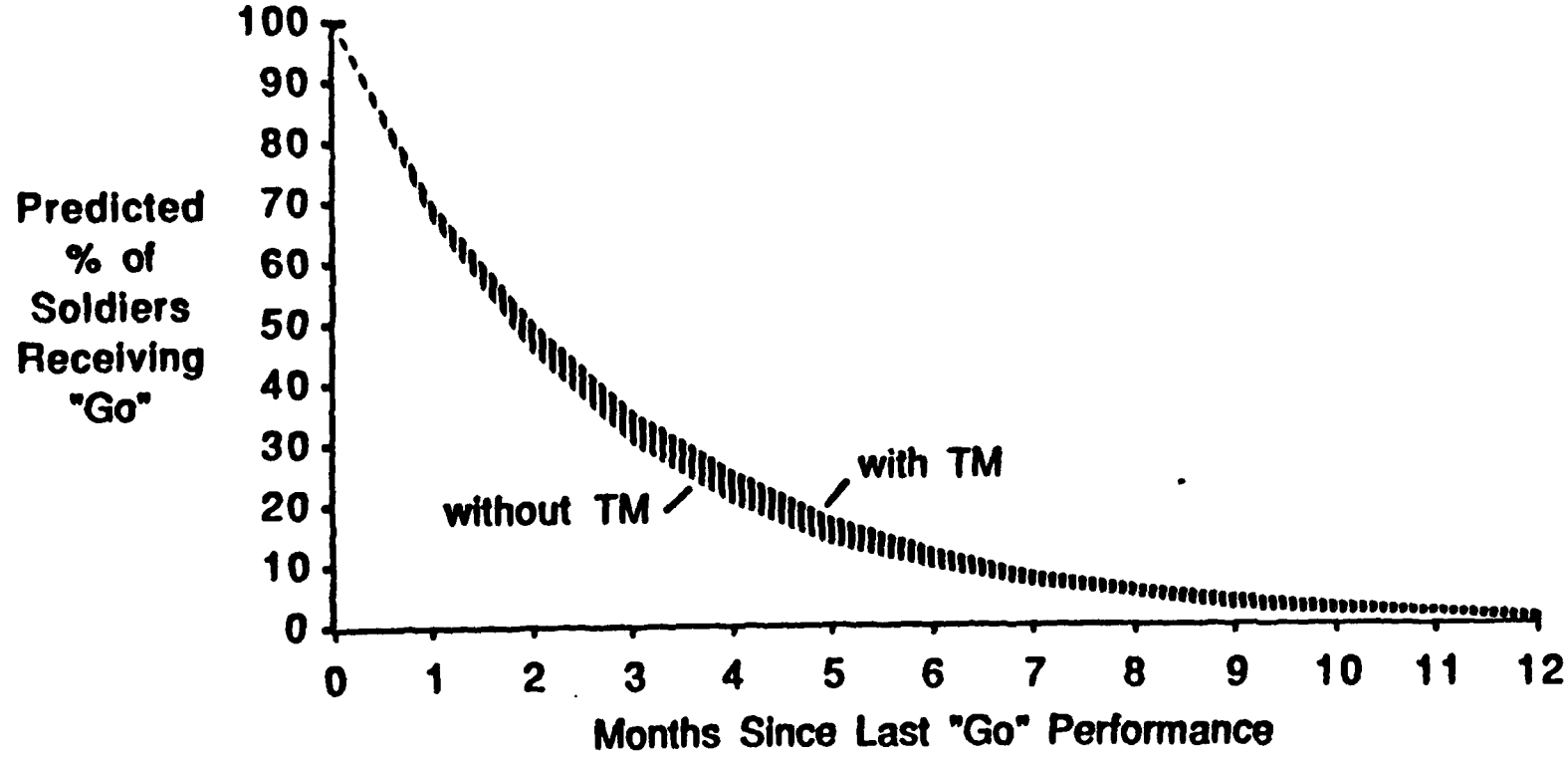
Perform a Bulk Transfer to Other Switches



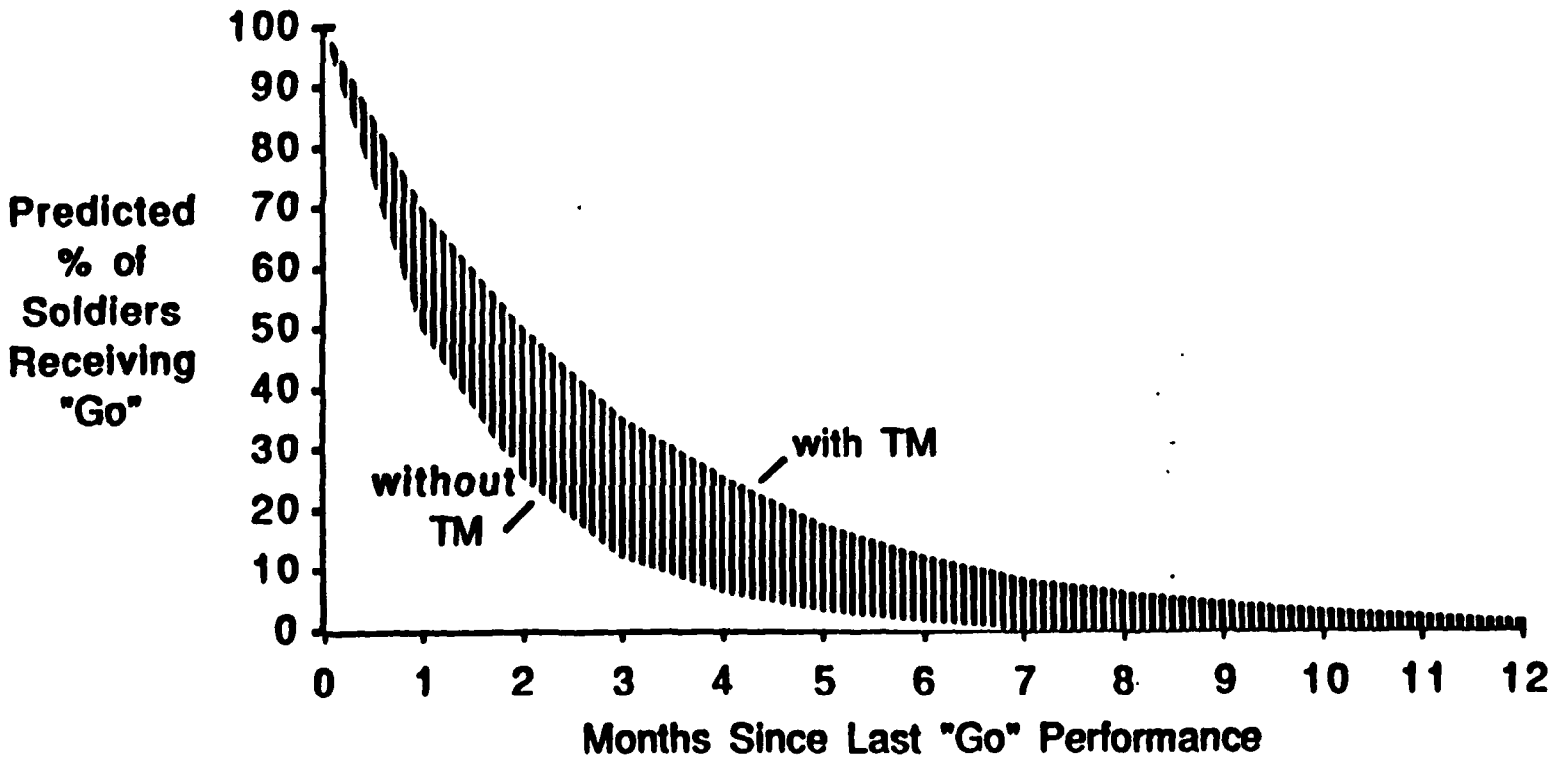
Initialize an Interswitch Link as the First Link of an MDTG



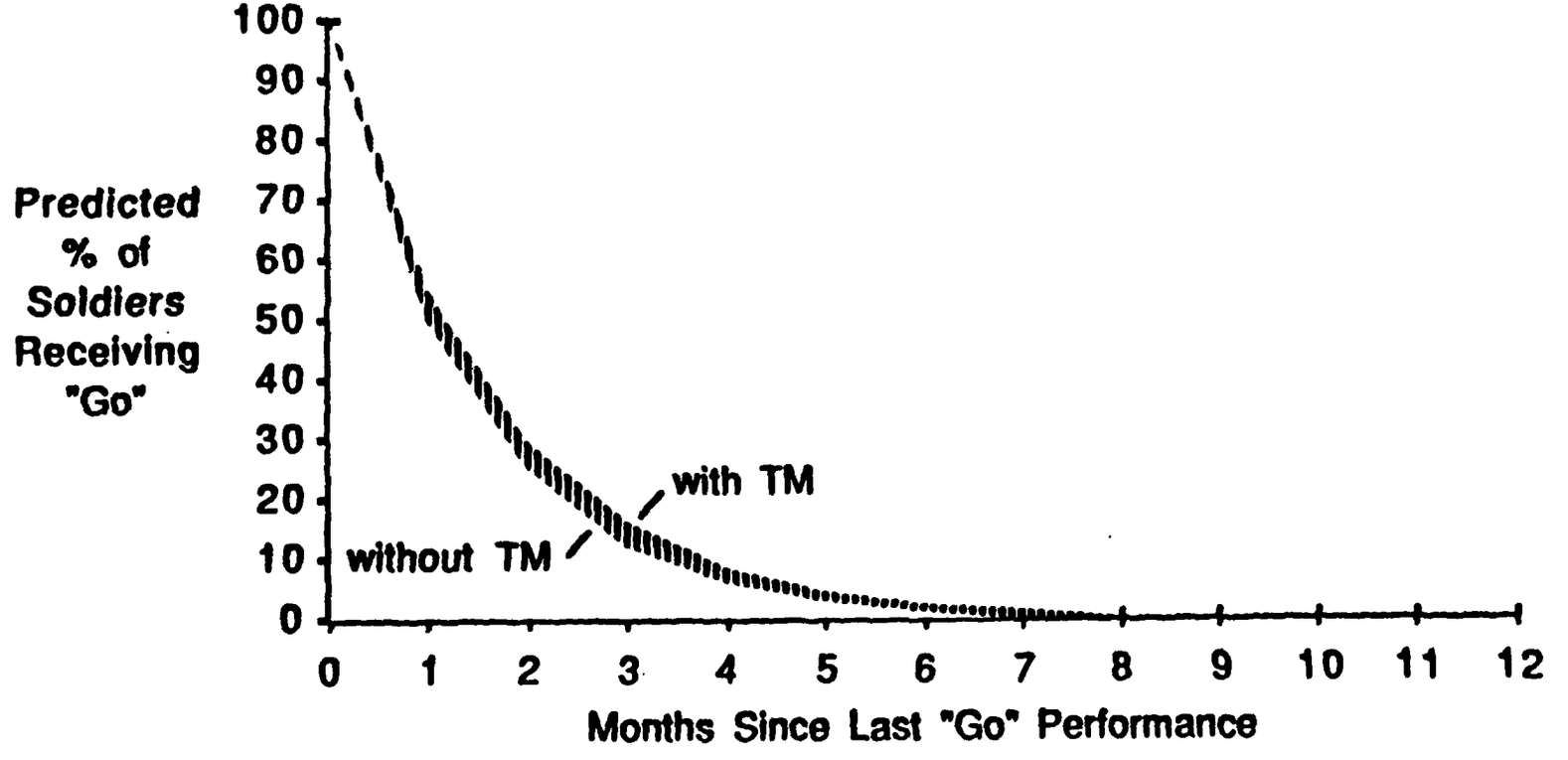
Perform Subscriber List Duplication to an Adjacent Switch



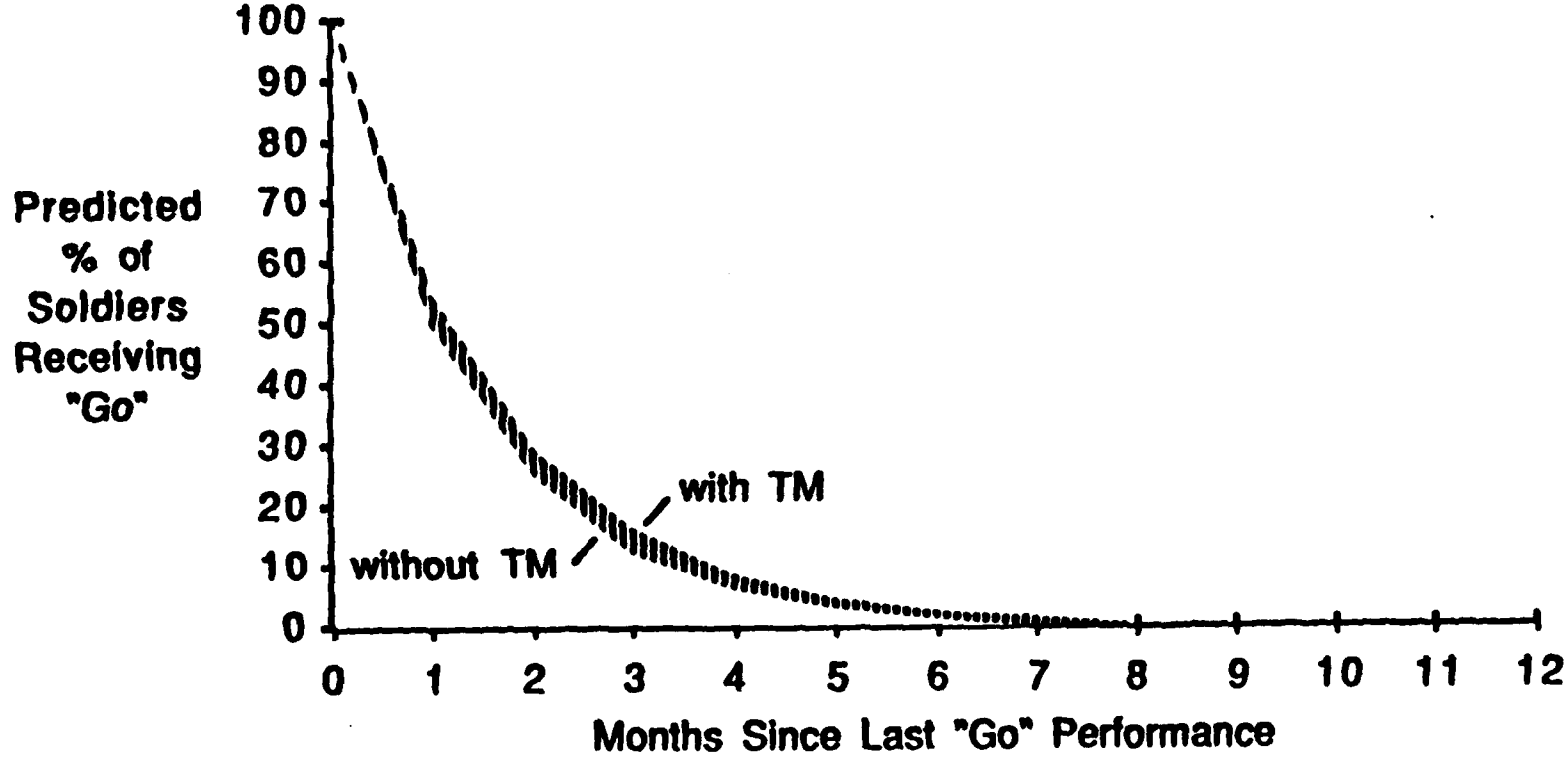
Perform Data Base Modification to Accommodate a NATO Analog Interface (NAI)



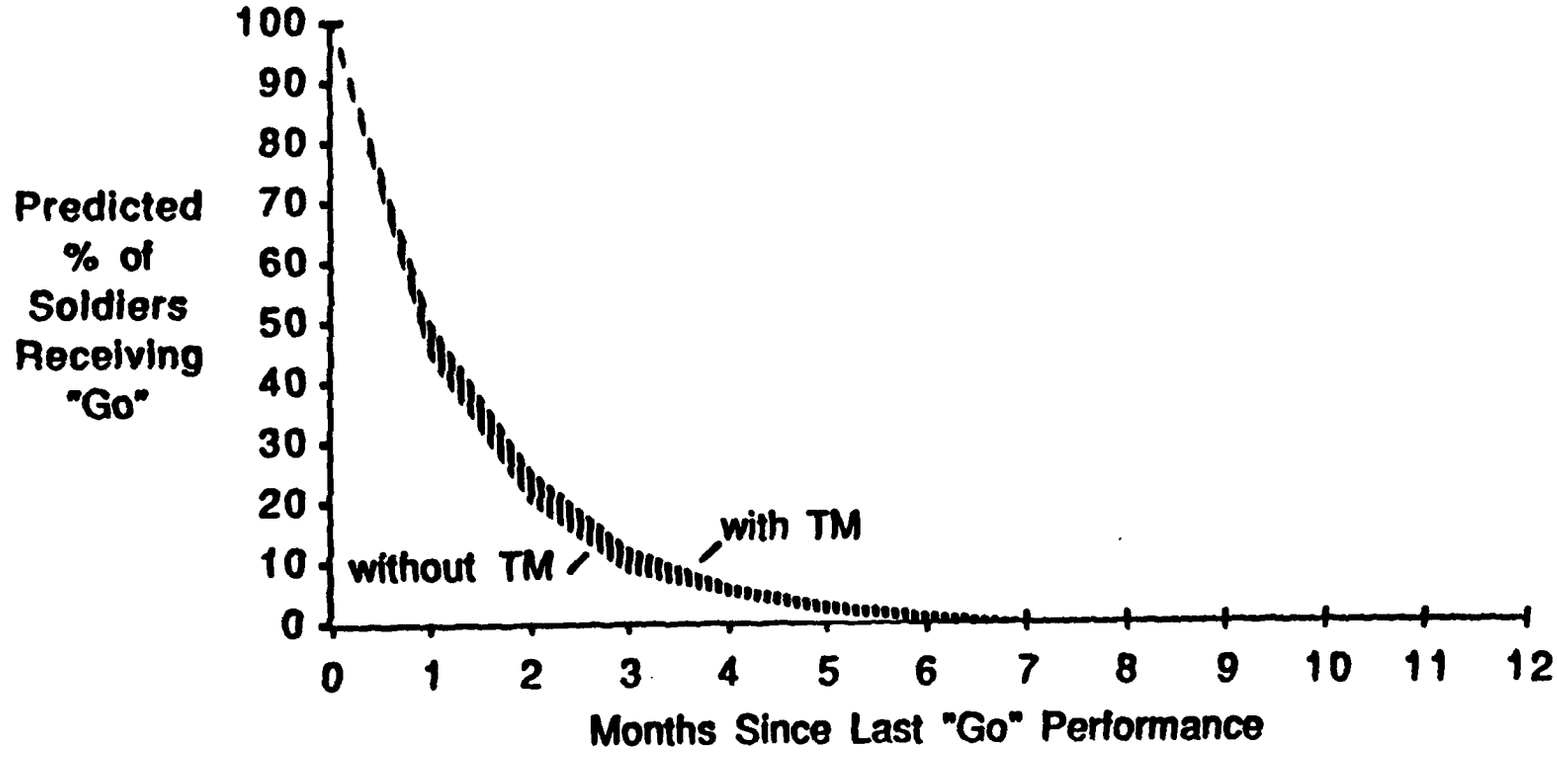
Activate Essential User Bypass (EUB) to an Adjacent AN/TTC-47 (NCS)



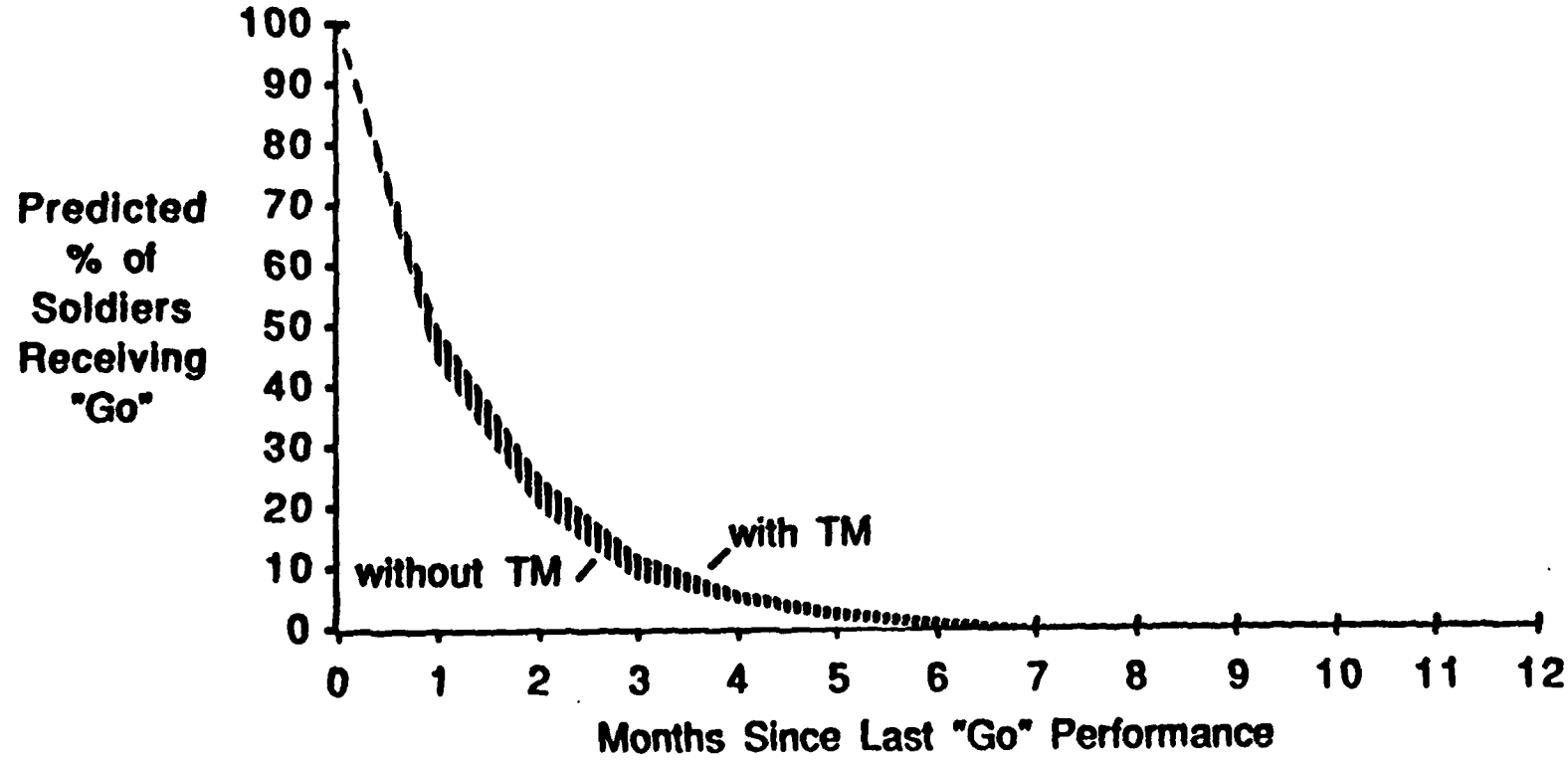
Initialize a Link Using the AN/GRC-224 (SHF Radio) as a Transmission Medium to the AN/TRC-190 (UHF Radio)



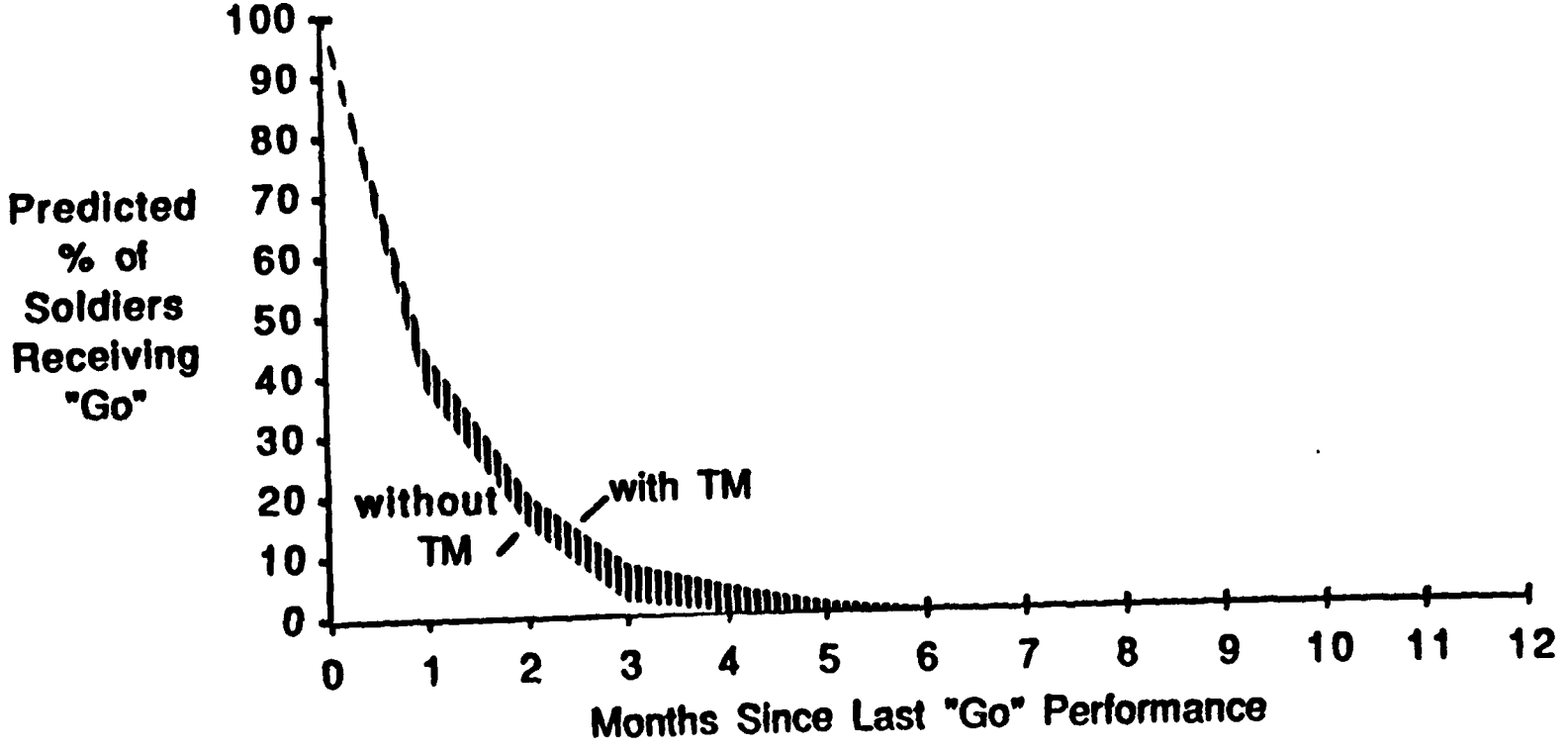
Perform Data Base Preparation for Essential User Bypass (EUB)



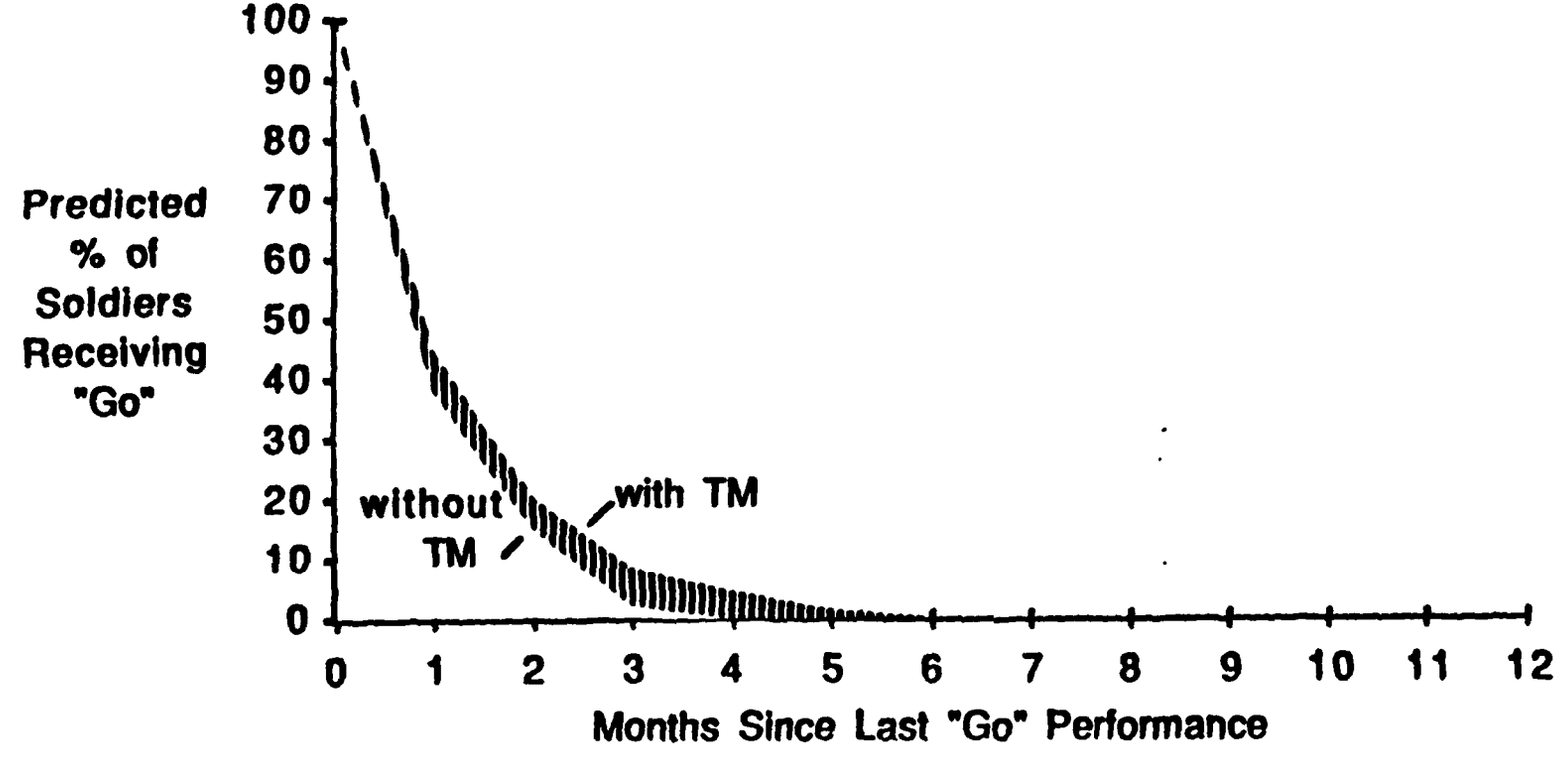
Perform Data Base Modification to Accommodate an Interface to a Commercial Office Using the AN/TTC-46



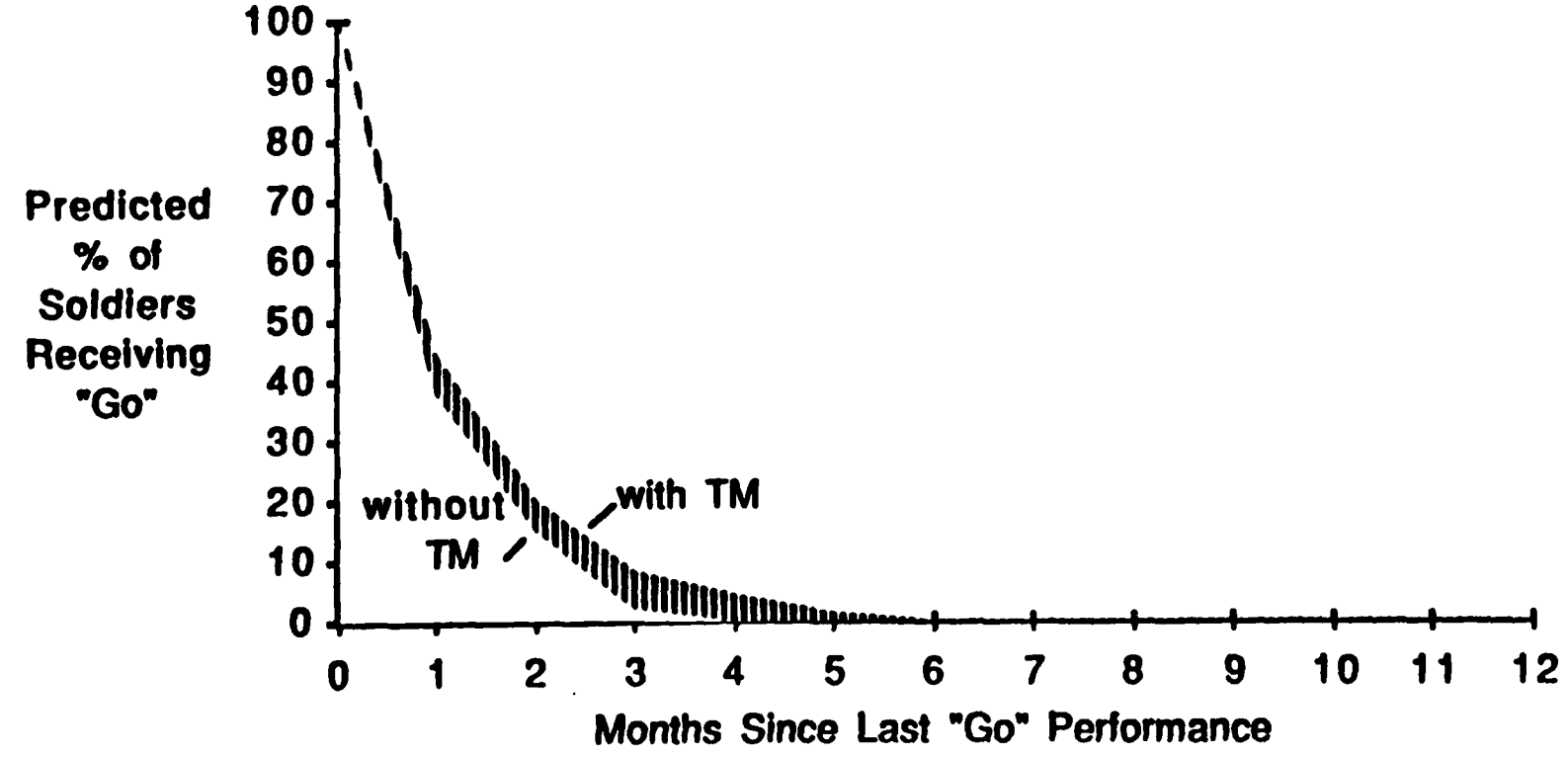
Perform Data Base Modification to Accommodate an Interface with an AN/TTC-39 or AN/TTC-39A



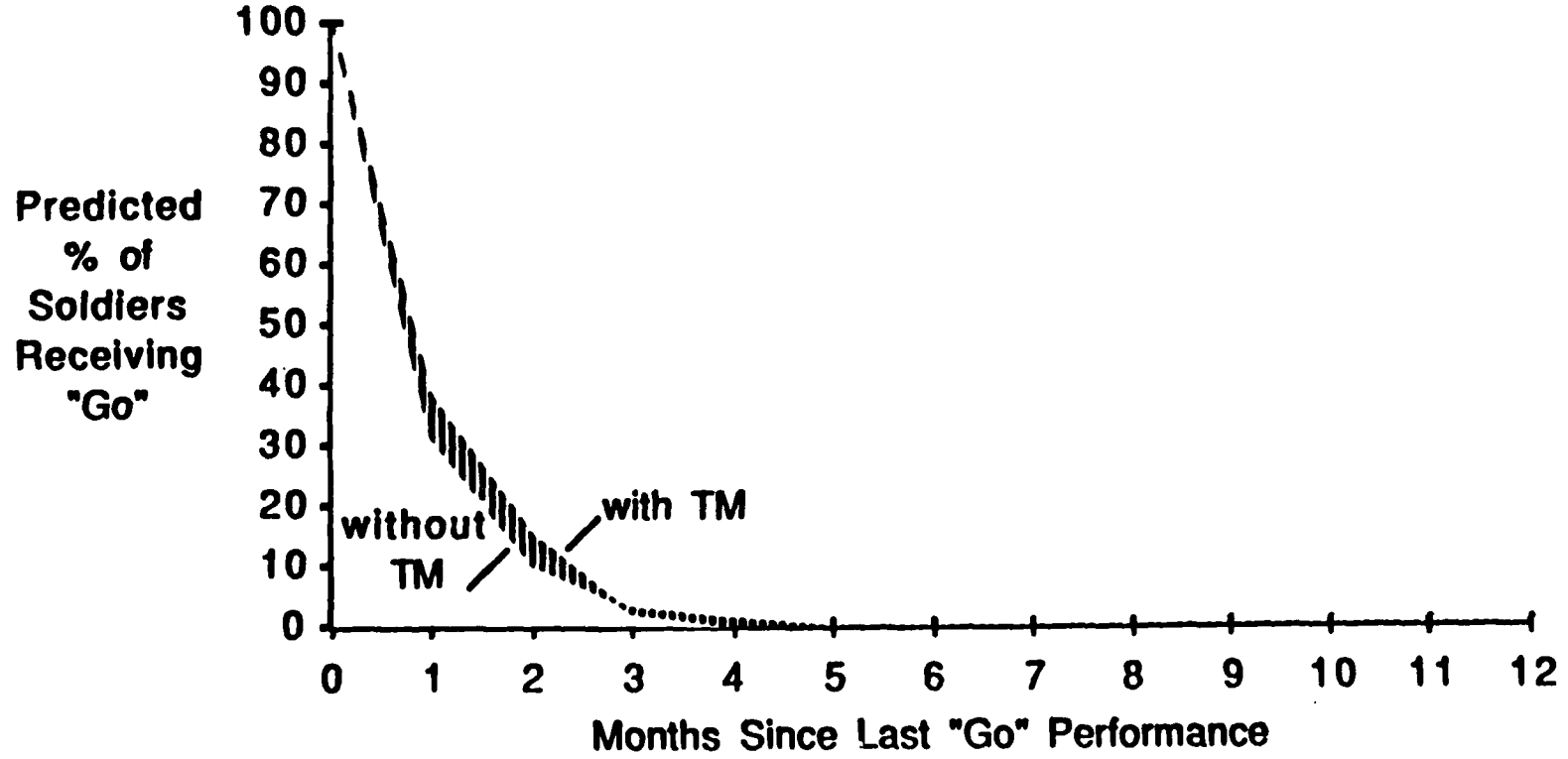
Restore System from an Essential User Bypass (EUB)



Modify an AN/TTC-48 DTG to an AN/TRC-191/AN/TYC-35 DTG



Modify an AN/TTC-47 DTG to an AN/TTC-48/AN/TRC-191/AN/TYC-35 DTG



Modify an AN/TTC-46 DTG to an AN/TTC-48/AN/TRC-191/AN/TYC-35 DTG